Holly

B. HOLLY'S SYSTEM

OF

WATER SUPPLY,

AND

Fire Protection

FOR CITIES AND VILLAGES.

Machinery Manufactured under [illegible], by the

HOLLY MANUFACTURING COMPANY,

LOCKPORT, N. Y.

T. T. FLAGLER, *President.*
B. HOLLY, *Mech'l Supt.*

CHARLES KEEP, *Sec'y.*
C. G. HILDRETH, *Treas.*

SEVENTH EDITION—FIVE THOUSAND EACH.

LOCKPORT, N. Y.:
M. C. RICHARDSON & CO., BOOK AND JOB PRINTERS, 91 MAIN STREET.
1875.

LIST

of places in which Holly's Plan of Water Works has been introduced or contracts made for the construction of machinery, viz :

No.	Name.	Population
1.	Lockport, N. Y.,	15,000
2.	Auburn, N. Y..	17,000
3.	Gouverneur, N. Y.,	3,500
4.	Ogdensburg, N. Y.,	12,000
5.	Binghamton, N. Y.,	16,500
6.	Peoria, Illinois,	25,000
7.	Batavia, N. Y.,	3,200
8.	Canton, Ohio,	12,000
9.	Kalamazoo, Mich.,	10,000
10.	Marquette, Mich.,	5,000
11.	Connersville, Ind.,	4,000
12.	Ironton, Ohio,	7,000
13.	Dayton, Ohio,	31,000
14.	Covington, Ky.,	25,000
15.	Columbus, Ohio,	32,000
16.	Indianapolis, Ind.,	50,000
17.	Jackson, Mich.,	12,000
18.	Norwalk, Ohio,	5,000
19.	Buffalo, N. Y.,	130,000
20.	Saratoga, N. Y.,	10,000
21.	Cumberland, Md.,	11,000
22.	Evansville, Ind	25,000
23.	Laporte, Ind.,	8,000
24	Columbus, Ind.,	6,000
25.	Schenectady, N. Y.,	11,000
26.	Syracuse, N. Y ,	50,000
27.	Portsmouth, Ohio,	12,000
28.	Denver, Colorado,	12,000
29.	Potsdam, N. Y.,	4,000
30.	Allegan, Mich.,	3,000
31.	Desmoines, Iowa,	11,000
32.	Big Rapids, Mich.,	2,500
33.	Youngstown, Ohio,	10,000
34.	Mansfield, Ohio,	9,000
35.	Dunkirk, N. Y.,	8,000
36.	Sedalia, Missouri,	5,000
37.	Memphis, Tenn.,	50 000
38.	Decatur, Illinois,	9,000
39.	Bay City, Mich.,	11,000
40.	Rock Island, Ill.,	9,000
41.	Saginaw City, Mich.,	9,000
42.	East Saginaw, Mich.,	11,000
43.	Danville, Pa.,	12,000
44.	Titusville, Pa.,	10,000
45.	Sacramento, Cal.,	25,000
46.	Norfolk, Va.,	20,000
47.	Rochester, N. Y.,	85,000
48.	Martinsburg, W. Va.,	7,000
49.	Port Huron, Mich.,	10,000
50.	Sidney, Ohio,	4,000
51.	Long Island City, N. Y.	12,000
52.	Hyde Park, Ill.,	10,000
53.	Flushing, N. Y.,	8,000
54.	Kansas City, Mo.,	50,000
55	Litchfield, Ill.,	4,000
56.	Pueblo, Colorado,	6,000
57.	Atlanta, Ga.,	30,000
58.	Middletown, Ohio.	6,000
59.	Evanston, Ill.,	8,000
60.	Rockford, Ill.,	12,000

B. HOLLY'S SYSTEM

OF

WATER SUPPLY,

AND

Fire Protection,

For Cities and Villages.

Machinery Manufactured under Letters Patent, by the

HOLLY MANUFACTURING COMPANY,

LOCKPORT, N. Y.

SEVENTH EDITION—FIVE THOUSAND EACH.

LOCKPORT, N. Y.:
M. C. RICHARDSON & CO., BOOK AND JOB PRINTERS, 91 MAIN STREET.
1875.

Holly Water Works System:

What it is—Its Advantages over Gravitation Works, Favorable Duty Tests of Holly Machinery, &c.

The manifold and glaring defects of the Reservoir or gravitation plan of Water Works are very generally admitted. It was natural to expect, therefore, that among the many inventions of this century there should be discovered a more economical, efficient and satisfactory method of supplying communities with water and protecting property from destruction by fire. This great achievement is accomplished by what is widely known as the "Holly System" of Water Works, recently invented and already in successful operation in upwards of SEVENTY cities and and villages.

The plan takes its name from the inventor, BIRDSILL HOLLY, and machinery and hydrants for works on this plan are manufactured under Letters Patent by the Holly Manufacturing Company of Lockport, N. Y., with which Company Mr. Holly is connected as Hydraulic Engineer and Mechanical Superintendent.

Serious Objections to Reservoir Works.

A few facts are given which abundantly prove the defects of gravitation works and the necessity of Holly's new and improved plan of direct pumping.

The eminent Hydraulic Engineer, W. J. M'Alpine, in a recent Report, says: "objections have been made to water which has been stored for use in reservoirs in some of our cities, because, at intervals of several years, it has become defiled for a few days during the warmest weather. This defilement is generally produced by the rapid production, either of animalculæ or of aquatic vegetation, the seeds of which, perhaps, lie dormant within the body of the water, or are carried to it by the air, or are generated when the water has remained stagnant

at a high temperature, for a considerable time, and, probably, when the atmosphere is in a certain electrical condition."

Sheffield, England, complains of the bad taste of people who choose the reservoir from which the supply of drinking water is drawn, as a place in which to commit suicide. *Ninety bodies have at various times been found in the water, to which they give a powerful but unpleasant flavor.*

Cincinnati has recently added a new Reservoir to her already costly Water Works, and in building it the bottom and sides were carefully cemented to hold the precious fluid. But now it is discovered that the process is a costly failure. The Cincinnati *Gazette* observes of it :

"It is interesting, in this connection, to remember that this job of plastering, which is now causing so much anxiety and wonderment, is the work of six or seven years, and cost the city an unheard of amount of money—*upward of* $250,000 *being expended for concrete alone.* What may not six or seven years bring forth in our seven million concern ?"

Oil City, Pa., having a high hill near by, thought to utilize it by placing thereon a Reservoir. The Titusville *Herald* thus speaks of the results of the undertaking :

"Our friends in Oil City unfortunately allowed themselves to be persuaded to adopt the old reservoir plan for their use. They are like the boy who draws his sled up the hill at enormous expenditure of muscle and time, that he may have the momentary pleasure of sliding down again. Where water is naturally found in sufficient quantity at the top of the hill to supply a whole city by natural flow, it might in some cases be advisable, in the absence of the Holly plan, to adopt the reservoir method. But the people of Oil City were not so fortunate. They are obliged to pump the water from the Allegheny river to the reservoir, at an elevation of 300 feet. It took them two years before they could make their reservoir hold water. After that, they found their machinery insufficient to pump the water to that elevation. Every gallon of water supplied to the city has to be pumped at the enormous pressure of 130 pounds to the square inch, requiring at least three times the power which would be necessary for ordinary domestic purposes, and consequently three times the expenditure for fuel ; and their reservoir requires constant repair. After all this additional outlay, Oil City is to-day drinking water from the Alleghany river, the purity of which is a question of grave doubt, whilst Titusville is now supplied by the Holly plan with spring water of the softest and purest quality."

The village of Conschocken, Pa., not long ago, undertook to secure a water supply by constructing a reservoir, and pumping into it from the Schuylkill river. The *Eagle*, published in the neighboring city of Reading, narrates the sequel to the $75,000 expenditure. It states that the discovery was made, one morning, that a portion of the reser-

voir had mysteriously disappeared. Upon investigation, it was found "that a portion of the southern embankment had sunk out of sight, leaving a hole about thirty feet in diameter; and, as the wall of the reservoir had disappeared, the water had vanished with it, with the exception of a small portion, about one foot and a half in depth, which was retained because the floor was uninjured, and because the cavity did not extend clear down to the floor. A cautious inspection showed that a portion of the embankment had dropped straight downward about twenty-five feet, and, upon looking into the hole at the top of the bank, it was discovered with the fence and the sod, at the bottom. The side of the vast hole contained a huge precipitous rock, down the side of which the earth had slipped. But the most remarkable thing about the accident was, that no water could be found in the hole. There were more than one million gallons in the reservoir at the time, and almost the whole of this had gone down the cavity and had disappeared utterly. What became of this vast body of water nobody knows. It has not turned up anywhere yet, unless it has broken through somebody's cellar floor in China. In the meantime, the Water Company is in sore affliction, and it is puzzled to know what to do about reconstructing its reservoir. The task of rebuilding upon a bottomless pit is not an easy one."

A disaster occurred, not long ago, to the reservoir from which, by gravitation, the city of Utica, N. Y., is supplied with water. The Utica *Observer* thus describes the fearful casualty:

"The damage to the Graefensburg Reservoir by the destruction of the embankment is very serious. The embankment gave way about 8 o'clock last Friday night. The water poured into the ravine below with tremendous force. Here it was held in check for a short time by the heavy snow drifts in that section. The snow blockade was soon lifted, and the flood, pouring through the ravine, shot down in the direction of the Mohawk, leaving destruction in its wake, until the great volume of water was emptied into our modest little river. One of the gate houses was carried away, and the barn of a farmer named Dodge was completely gutted. Horse, wagon and everything else were cleaned out most speedily. The animal escaped by paddling ashore. The bridge over the Starch Factory creek, on the Welsh Bush road, is carried away. This was a new structure. The breakwater near the Minden turnpike is also damaged. Near the Starch Factory the canal is badly washed out. No estimate of the damage can now be made."

In March, 1875, the Long Island dam, a part of the Reservoir system of Water Works of Brooklyn, which has been in a leaky condition the past two years, gave way, and the water confined by it, to the

amount of 3,000,000 gallons, has swept away a portion of the South Side Railroad track, and inundated the immediate neighborhood to the depth of two or three feet.

The above specimens of cost, danger and unreliability of reservoir plan of water supply indicate that a new and improved method is m peratively demanded, unless the other gravitation method of supplying water by the erection of a stand pipe meets the wants of communities in this particular. In a few instances this has been tried, but only to make prominent the

Defects of Stand-Pipe Works.

Aside from the increased cost in comparison with works on the Holly plan, the stand-pipe is still more defective and objectionable than the reservoir, as a means of water supply. A few localities have incautiously adopted this method. Toledo, Ohio, is one of them. In the very construction a mortifying and expensive thing happened, as detailed in the following newspaper account :

"At Toledo, Ohio, Aug. 29, several thousand people were assembled at the water works, to witness the raising of a stand-pipe, which was built in one continuous piece of boiler iron, 228 feet long and 5 feet in diameter. Every preparation had been made the day before, and at 9 o'clock the big lift was begun. All went well till 10.45 A. M., when the pipe was within perhaps 20 degrees of perpendicular, when the strap of a block gave way, and the whole mass of 32 tons fell with terrific force. The first hundred feet are uninjured, but the rest is ruined. It lies in three pieces."

The works having been put in operation, with the uninjured portion of the stand-pipe in position, the next great event which happened was that the winter of 1874–5 turned it into an ice house ! ! ! South Bend, Indiana, having copied the example of Toledo, in the construction of stand-pipe works, like her sister city, had great trouble in the placing the stand pipe in a perpendicular position, and the South Bend stand-pipe, like that in Toledo, froze up about the same time. The South Bend *Register*, speaking of this monument of folly which had been erected there, says :

"The stand-pipe erected by Philip Berger, contractor, has been finished at an altitude of about 225 feet and has consumed about half a million brick. It is a costly structure, well built, OF DOUBTFUL UTILITY, and cannot claim to be an ornament. Water is abundant, EXCEPT WHEN THE STAND PIPE IS FROZEN."

Jersey City, N. J., is ornamented with a stand-pipe. It not only froze up, but the top tumbled over, and for a time the luxury of water was indulged in there at the rate of *twenty five cents per pail!!*

Why stand-pipes are built at all is explained by the editor of the South Bend *Register*. He states that it is "because the stand-pipe is a contrivance of the past, only young and active in those parts of Pennsylvania where they are still voting for A. Jackson for President."

What is the Holly System?

The object, as set forth in the specifications accompanying the letters patent granted Mr. Holly, is declared to be "not only to supply cities with water for ordinary purposes, at any desired elevation, without the use of a reservoir or stand-pipe, or any other contrivance for calling into requisition the principle of the hydrostatic equilibrium, but also to furnish the means of extinguishing fires at several points at the same time, if necessary, and all this without the use of any movable engine for that purpose."

This is accomplished by placing a set of Holly Pumping Machinery within a frost proof and fire proof building, located at a convenient point where the supply of water is accessible, and from whence, by a proper system of pipes, the water can be conducted wherever it is needed. The pumping machinery must be adequate to the service required, having a reserve for extraordinary occasions. This machinery may be propelled either by water or steam power. Experience has demonstrated that the best combination is the Holly Piston Pumps (with several cylinders taking stroke in succession,) for daily supply under low pressure, and the Holly Patent Eliptical Rotary in reserve for powerful efficient fire streams. By means of the Holly Hydrostatic Regulator and other ingenious contrivances, the motion of the machinery is put under the control of the pressure of water in the street mains supplied by it, and the movement is thus increased or diminished in exact ratio to the increase or diminution of the draughts from those mains. Suppose the ordinary domestic pressure to be maintained in the pipes is [illegible] pounds to the square inch. Now, any considerable draught, such as the opening of a fire hydrant, or several service cocks at the same time, will necessarily suddenly diminish the pressure, at the same time requiring an increased supply of water. In the shutting down of one or more fire hydrants, or several service cocks at the same time, the

pressure will be necessarily suddenly increased and the supply of water required diminished—exactly opposite results. To meet this varying demand reliably, by maintaining a uniform water pressure, is the office of the Holly Hydrostatic Regulator, and this it does automatically and with certainty. Its operation may be briefly described as follows : The Regulator is provided with a piston, placed within a piston chamber, and having a rod extending outward, which is connected with a cross-bar, having heavy weights attached to prevent a sudden or spasmodic movement. A small pipe connects the piston chamber with the water mains, so that any change in the pressure of the water is at once communicated to the piston, causing it to rise or fall as the pressure is increased or diminished. In this manner a mechanical movement is secured, which, being transmitted by simple appliances, causes the valve of the engine (or the gates of a water wheel) to admit or cut off the steam (or water power), thereby increasing or decreasing the power of the engines, the speed of the pumps and the quantity of water supplied. Thus the pumping machinery responds to the varying demands for water, securing its flow—without any circumlocution or extra lift into reservoir or stand-pipe—to the precise spot, and in the exact amount needed for use, either in daily supply or in throwing fire streams from hydrants.

To guard against the contingency of accident, the machinery is duplicated, and in large works triplicated, so as to avoid any interruption in the water supply.

GREAT ADVANTAGES OF THE HOLLY SYSTEM

In the enumeration of these advantages over the old gravitation plan, which it is fast superseding, it is proper, first of all, to name its

Economy of Construction.

The reduced cost of Water Works on this system brings them within the financial ability of communities which could not afford to build on the Reservoir or Stand Pipe plan. Of the 70 places which have adopted and put in operation these Works, probably two thirds would be without them to-day if they had been obliged to incur the largely increased liability of works on the old gravitation method.

The city of Peoria, Illinois, was one of the first to adopt the Holly system, and this after maturing measures for Reservoir Works. A Committee of the Council, after a thorough examination of comparative merits, reported unanimously their "opinion that it will be well for the city to adopt the Holly plan. By doing away with a Reservoir and the necessary force main, we can SAVE ONE HUNDRED THOUSAND DOLLARS IN EXPENSE."

Columbus, Ohio, adopted the Holly plan because a Committee of the Council, after a tour of inspection, and thorough examination, reported that this system "vastly exceeds in value the old Reservoir System in usefulness, and at the same time costs, in the judgment of your Committee, NOT MORE THAN ABOUT ONE HALF IN THE EXPENSE OF BUILDING."

East Saginaw adopted Holly's plan because her officials became satisfied, and declared his method to be "the CHEAPEST AND MOST APPROPRIATE FOR OUR CITY."

The Common Council of Bay City, Michigan, adopted Holly, among other reasons, because, as expressed in the resolution, it was found to be "MORE ECONOMICAL than any other system now in use."

The above quotations might be multiplied indefinitely, but it is deemed needless, since the fact of economy in construction is too plain to be seriously questioned.

Another important feature which recommends Holly's plan of Water Works is, that it secures a

More Reliable Daily Water Supply

An inherent defect in gravitation works is, that pressure in street mains is due to the height of the reservoir or stand pipe, and they cannot be elevated or depressed to yield pressure and a flow of water conforming to the ever changing draught upon the street mains; and consequently water takers in the more elevated portions of the area of distribution are often entirely without water, or are only partially supplied when their want of water is most urgent, and the lack of it most inconvenient and injurious. With Holly's process, on the contrary, the pressure may be varied according to the demand for water, and its reliable flow to the highest point of distribution is secured. This is a marked advantage of the Holly plan over gravitation works.

Holly Plan Available at Extreme Heights and Distances.

The idea has been industriously circulated that the Holly Plan is only suitable for small places, and on a small scale, when, in fact, it is susceptible of enlargement to meet fully the wants of the largest city on the face of the globe. This enlargement may be either by increasing the size of machinery, or by multiplying sets of machinery, or both of these modes combined, and with corresponding enlargement and extension of street mains. It also provides for supplying water at higher elevations and longer distances than can be done with works on the gravitation plan.

In Peoria, Illinois, the supply, both for daily use and efficient fire protection, includes an elevation of 206 feet and a distance of two miles from the pumping machinery. The Sedalia, Missouri, Holly Works are three miles from the city, and supply water at an elevation of 120 feet. Youngstown, Ohio, has water supply at 150 feet elevation, and Mansfield, Ohio, 175 feet elevation above the pumps. In Cumberland, Md., the height supplied is 144 feet. Danville, Pa., 145 feet, and Kansas City, Missouri, nearly 300 feet elevation. At Norfolk, Va., the Holly pumping machinery is about five miles from the city, and provides reliable daily supply, while it has also thrown four effective fire streams direct from hydrants in different parts of the city. In the villages of Hyde Park and Lake, Illinois, which are both supplied from one set of Holly machinery, six fire streams were recently thrown each more than 100 feet high direct from hydrants located 8½ miles from the pumping works. A set of works is now being constructed by the Holly Co. for the city of Atlanta, Ga., which are to be located 4¾ miles from the city, and which are guaranteed by the Company to supply water, and throw fire streams against a pressure equivalent to 340 feet elevation. Dayton, Ohio, has about 40,000 population, and has Holly Works supplying this population, with over 30 miles of street mains. Columbus, Ohio, with its 50,000 inhabitants, has Holly Works supplying its citizens with water, through 33 miles of street mains.

Indianapolis, Ind., has a population of nearly 60,000, which has had a partial supply for several years, through 20 miles of street mains, and is about to increase it to 40 miles, and make corresponding additions to its Holly pumping machinery. Rochester, New York, has a population of 80,000, and contracted with the Holly Co. for machinery capable of supplying fire streams through 100 hydrants, located on

eight miles of main pipes. After a year's trial, the Board of Water Commissioners, in their annual report, say :

"From the Genessee river we are now pumping water into OUR FIFTY MILES OF PIPE connected with 478 hydrants. Every fire district, except one, is now embraced within the protection of our water works. From any hydrant in that large area of territory, actual trial has demonstrated that a stream of water may be thrown at least 100 feet high with 100 pounds of pressure upon the pipes at the engine house. And more than that, ten such streams of watei may be raised to the same height under the same pressure, and from any ten hydrants at once. To do this, we have pumps which are worked with water power at a merely nominal cost ; or if those should fail, we have steam engines working directly on piston pumps, or piston engines which may be connected with rotary pumps, or rotary engines to work rotary pumps."

The above statistics prove beyond cavil that works on the Holly plan are competent to meet the wants of cities of the largest size, and to reach out and secure reliable daily supply not only, but fire protection at extreme heights and distances, through large areas of street mains.

In the next place, it is to be noticed that Holly's plan provides for prompt and adequate pressure for throwing powerful fire streams direct from hydrants, and is therefore, in the suppression of fires,

Far More Efficient than Movable Engines.

A record of the numerous instances in which this has been demonstrated would fill a volume.

The city of Rochester, New York, adopted the plan because her Water Commissioners ascertained, among other things, that "the great and peculiar merit of the Holly System is, that within three or four minutes of the receipt of fire alarm it will supply a pressure sufficient to throw a stream or streams over the highest buildings, from any hydrant connected with the works—thus entirely superseding the necessity of fire engines for the protection of property within the territory ramified by water pipes."

These expectations were fully realized, for, after a year's experience, the Chief Engineer stated in his report :

"A considerable number of fires occured within the district covered by the water mains, and in no case has the fire been extensive, but has almost invariably been confined to the building in which it originated. In almost every instance the building itself has been saved from entire destruction. *The streams*

from the hydrants have in every case been very effective, and on no occasion have the works failed to respond to every demand made upon them, either at a fire or otherwise. Fires have been extinguished by streams of great power from hydrants 1,600 *and* 1,700 *feet distant.*"

The Board of Water Commissioners, in their report, make the following important statements in corroboration of the Chief Engineer:

"Some of our citizens have, on one occasion, seen four hydrant streams thrown at once, each 100 feet, vertically into the air, under 100 pounds pressure at the pumps, after the water had been forced through nearly three miles of pipe and fifty-nine feet above the engine house.

"A fire was lately extinguished in the remote northwestern part of the city by streams thrown from hydrants 1,700 feet, or nearly a third of a mile away from the fire. The wooden building which burned had been nearly consumed, except the front, before the hose could be laid to carry the streams. But so rapid was the work of the streams when brought to play, the front of the building was saved without injury beyond five dollars in value.

"All these astonishing results have been exhibited, together with a continuous service for a year, and not a single joint has been forced, out of over 25,000 made. Every pipe laid has been tested at 130 pounds after it was laid, thus presenting a rare advantage for assuring perfect construction, which our Holly system has enabled us to obtain.

"NO STEAMER OF THE FIRE DEPARTMENT HAS PLAYED UPON A FIRE IN THE DISTRICTS COVERED BY THE WATER WORKS FOR MONTHS; NOR IN THE PAST YEAR HAS A FIRE OCCURRED WITHIN THE RANGE OF HYDRANTS OF THE WATER WORKS WHEN HYDRANT STREAMS HAVE NOT PLAYED FIRST UPON IT AND HAD IT WELL UNDER CONTROL BEFORE THE STEAMERS HAVE BEEN READY TO PLAY THEIR STREAMS UPON IT."

The Commissioners hold that, notwithstanding the Fire Department had in use 7 steamers when Holly was put in operation, "*the city was absolutely without fire protection, except within a distance of five to ten hundred feet of the Erie canal. The Holly system has, perhaps, already saved property enough in one year to pay all it has cost.*"

For the reason that the Holly provides a better mode for the suppression of fires than steamers and hand engines, the introduction of Holly Works is generally succeeded by

Selling Steam and Hand Engines.

In Lockport, New York, where the Holly Works were first put in operation, of the three hand engines in use, one has since been sold

and the other two held for use beyond reach of the hydrants. Within reach of hydrant service they are never taken out at a fire.

Next to Lockport, works on this plan were brought in use in Auburn, New York. Auburn has a population of nearly 20,000. She had three hand engines, two of which have been sold since the introduction of Holly Works, leaving one on hand, "which is stored in the second story of a building." In all these many years, therefore, Auburn has dispensed entirely with movable engines, and has relied wholly and satisfactorily upon the fire protection of the Holly Works.

Next in point of time was the introduction of Holly Works into Peoria, Illinois. That city has since sold two steam engines and two hand engines, leaving on hand one hand engine, which the City Clerk, in a letter of recent date, states "is very seldom taken out of the house in which it is stored, as it is of no use on the line of the water mains, and of very little use outside, because there is no water." Practically, therefore, Peoria, with its 35,000 inhabitants, rests its defense against fire wholly upon what the Holly Works can do for them.

In Saratoga Springs, New York, as a consequence of the putting Holly Works in operation, all three of its hand engines have been sold, and one of its steamers, and, says a letter from the Chief Engineer, the remaining one "is for sale cheap." Since the introduction of Holly Works, there have been but two occasions where the steamers have been used, and then, says the same letter, "the streams direct from the hydrants did better execution than the steamers." In addition, it is stated that "our citizens consider every fire plug far superior to any steamer, as they are always sure and reliable, and always on the spot."

When Holly Works were introduced into Norwalk, Ohio, she had two hand engines. One has been sold, and recent information from that village states that there "never has been any occasion for using the remaining one since the better protection of the Holly Works has been afforded. There have been many fires, but no building has been destroyed, nor has the fire spread to the second building or block."

The village of Allegan, Michigan, has a small set of works on the Holly plan. She had one hand engine, which is still on hand, but not used within reach of the Holly hydrants. A recent letter from the Superintendent, A. J. Kellogg, Esq., says: "The Holly has saved the whole business part of the village from destruction on three different

occasions. Our citizens would not exchange the system for movable engines, or any other plan."

Holly Works have been in operation in Rochester about one year. Its bearing upon steamer service is thus stated in a recent letter from J. Nelson Tubbs, Chief Engineer. He says:

"The city of Rochester owns seven steamers, and in consequence of the partial construction of our works, THREE OF THEM HAVE GONE OUT OF SERVICE, AND ARE OFFERED FOR SALE. Four are still in service. That is, the organization is kept up for four steamers, but they are very seldom used at a fire. It is the intention as soon as some further extensions are made to DISPENSE WITH TWO OTHERS."

In the annual report of the Board of Water Commissioners, recently made, the substitution of the Holly Works, instead of steamers, is thus commented upon:

"Our citizens have become accustomed to repose with confidence upon the never-failing protection of our water works, and the prompt efficiency of the fire department to set the hydrants in play as soon as the alarm is sounded. No longer does the dread alarm bell startle from sleep as it sounds at midnight, when biting frosts or rushing winds make the thought of fire seem terrible. We lift our heads from our pillows and listen for the stroke of the bell and count their numbers. We do it twice or thrice, or more perhaps, and then the alarm ceases. The firemen have reached the spot, the hydrants have begun to play, and all danger is passed."

The city of Schenectady, N. Y., has sold two of her steamers, and reserved one, which is held for use beyond the reach of hydrants, relying upon fire streams direct from hydrants under pressure from Holly Works machinery.

Ogdensburg, N. Y., sold two of her steamers when Holly Works were introduced, reserving one for the same reason and purpose as Schenectady.

In LaPorte, Indiana, after putting Holly Works in successful operation, the Common Council disbanded the fire company connected with the steamer, and ordered it sold, because in Holly a better mode of fire suppression was inaugurated.

Rock Island, Illinois, also sold out her two steam fire engines, after ascertaining by thorough trial, the greatly increased efficiency of her Holly Works for fire protection.

In Des Moines, Iowa, the Chief Engineer of the fire department, William Nefie, Esq., recently made a report to the Council of that city, concluding as follows:

"I would recommend to your honorable body the sale of the steamer General Crocker, for the reason:

"That the fire department has at all times during the past year been promptly furnished by the water works with an abundant supply of water for fire purposes.

"The water works, during such time, have more than equalled the expectations of the fire department, and in no case have we been delayed by said works in the extinguishment of fires.

"We have been enabled thereby to stay the spread of fires in the city, and in every instance within the reach of the hydrants, to extinguish the fire in the building where it originated.

"I have had twenty years experience as a fireman with the most approved steam and hand engines, and I know of no system of extinguishing fires that will excel the Holly Works, and think all we need to have a perfect fire department is a fire alarm telegraph, which I would recommend be at once purchased."

Dunkirk, New York, sold one of her hand engines upon the introduction of Holly Works, and offers the other for sale, since after two years' experience, there has been no occasion for its use.

The Superintendent of the Titusville (Pa.) Holly Water Works, (M. E. Bassett, Esq.,) under date of April 10, 1875, states that "our City has sold one steamer since the works were introduced, and offers for sale another steamer and two hand engines—reserving one steamer only for use outside the lines of water mains."

J. R. Armstrong, Esq., Secretary of the Columbus, Ohio, Board of Water Works Trustees, in a letter dated April 12, 1875, states: "The City owns four steamers, one of which is kept in service and stationed in the north part of the City, beyond reach of the water mains. The City would do well to sell the other three, as they are practically of no use in the extinguishment of fires, within reach of the fire plugs."

The above statements prove the general fact that where Holly goes in, steam and hand engines "step out," and go at reduced prices to those locations which are either without water works or else have them on the reservoir or stand-pipe plan, which, it is notorious, scarcely supply the movable engines with water, and cannot be relied upon for fire streams direct from the hydrants.

In considering the value of Holly's plan for fire purposes, it is also to be borne in mind that while it drives fire engines out of use, and puts money into city treasuries for the proceeds of their sale, it also

Reduces the Aggregate of Losses by Fire.

The Chief Engineer of the fire department in Rochester has reported to the Common Council, that the losses by fire in the city during the year 1874, amounted to $73,000. And he justly takes occasion to remark, "That when we consider that during the year there were between 70 and 80 fires, it certainly seems marvellous that there should have been, comparatively speaking, such trifling losses.

"The total amount of losses by fire in Rochester, for *six* years previous to 1874, was $900,380, or equal to an average annual loss of $150,000.

"THE SAVING, THEREFORE, CAUSED BY WATER WORKS THE FIRST YEAR IN THIS DIRECTION ALONE, IS EQUAL TO $77,000.

"The comparison of the past six years is the only fair and proper one, as it has been during that period that our valuable and efficient fire department has been brought to its perfection of equipment, thoroughness of discipline and personal efficiency."

This Saving of $77,000 Caused by Water Works.

That the saving in loss by fire has been effected by water works, is well known.

In Norwalk, Ohio, Ex-Mayor O. A. White, in a letter dated March 25, 1875, says:

"The losses since the completion of our water works have been much less than before. *In one instance we saved more than $15,000 beyond a question, and where no steamer or hand engine would have availed us.*

"We have had many fires, but no building has been destroyed, nor has the fire spread to the second building or block."

In his annual report for 1874, Chief Engineer Hyde of Saratoga Springs, N. Y., speaks as follows of the operation of the Holly Works in the suppression of fires:

"All of the fires have been confined to the buildings in which they originated, and with our present system of fighting fires we can master any of them. I can safely say that no fire can show light for over ten minutes, after an alarm and the firemen on the ground.

In contrast with this result, the Chief Engineer of the water works, D. L. Holland, in a recent letter, says:

"Before the Holly Works were introduced, every time a fire occurred, the building in which it originated was totally destroyed, and also contiguous property along with it. I cannot recall an instance where even a portion of a building was saved by the old way of fighting fires by the aid of steamers. Generally the *building was always burned down before the steamers got on the ground ready for work.* During the past three and a half years, since the introduction of our noble Holly system of water works, we have not lost but two buildings entire (and then it was no fault of the works), and the *amount of contiguous property saved would foot up* MILLIONS OF DOLLARS."

The City Clerk of Peoria, Illinois, (H. H. Forsyth, Esq.,) in a letter dated March 27th, 1875, says:

"I cannot say what the difference in yearly losses by fire is since the introduction of water works, but can say this, that we never have had a fire extend beyond the building in which it caught since the introduction of the Holly System."

A. H. Goss, Esq., Secretary of the Auburn Water Co., in a letter of 20th of March, 1875, makes the following statements as to the efficiency of Holly Works, after several years' exclusive reliance upon them, without any aid of movable engines, for the suppression of fires:

"Since many years it has been in use, in *no case has the fire extended beyond the building in which it originated*, and in most cases the building mostly saved. I should think two-thirds of the fires which have occurred, have been stopped with slight damage. We have stopped large fires in blocks in the building in which it originated, that in my opinion no other system of fire protection would have prevented destruction of the whole block.

"I can say that *since Holly Works were introduced losses by fires have been largely reduced*, although our city has added one-third to its population."

J. T. Williams, Esq., Secretary of the Board of Water Commissioners in Dunkirk, New York, in a letter dated March 29th, 1875, states:

"Our annual losses by fire HAVE NOT BEEN ONE-TENTH SINCE THE INTRODUCTION OF HOLLY WORKS, what they were before our village availed itself of this new and most effective mode of fire suppression."

F. M. Hubbell, Secretary of the Des Moines Water Works Co., in a letter dated March 31, 1875, states:

"The losses by fire since the introduction of the Holly system *have been a great deal less than when our only protection was the steamer.* There has been no house entirely burned since the works were put in, and no very large loss. We always put out the fire."

In Titusville, Pa., the Superintendent of the works says: "The losses by fire are LESS THAN ONE-THIRD IN AMOUNT since the introduction of the Holly Water Works, and no fire has spread beyond the building in which it originated. The Holly System is a perfect success, and very satisfactory to our citizens."

The Superintendent of the Mansfield (Ohio) Holly Water Works, in his report for 1874, give the following comparative statement, showing that Holly as a fire extinguisher reduced the fire losses to one ninth what they were before it was put in operation:

"The following shows the losses by fire in our city for the twenty months prior to the erection of the Water Works, and the twenty months since the Works have been in actual operation:

Total loss by fires from January 1, 1871, to September 1, 1872, being 20 months	$92,340 00
Total loss by fires from September 1, 1872, to May 1, 1874, being 20 months	10,999 00
Amount to credit of Water Works	$81,341 00

I have also prepared, with great care and from the most reliable data that can be obtained, the probable saving of property by the prompt and speedy extinguishment of fires during the past twenty months that the works have been in active operation, and the gross amount foots up the sum of $106,500.

This is the very best argument we can offer for the efficiency of the Water Works as a fire extinguisher. These are no fine-spun theories, based upon doubtful propositions, but plain and indisputable facts, carefully compiled from the most reliable data."

The Holly Water Works have been in operation in Columbus, Ohio, four years. Under date of April 10, 1875, the Chief Engineer of the Fire Department, (H. Heimmmiller, Esq.,) makes the following comparative statement of the yearly losses by fire for four years, before

and since the Holly Works were put in use. The following is the statement.

YEAR.	NO. FIRES.	TOTAL LOSS.	YEAR.	NO. FIRES.	TOTAL LOSS.
1867	[illegible]	[illegible]	1871	[illegible]	[illegible]
1868	[illegible]	[illegible]	1872	[illegible]	[illegible]
1869	[illegible]	[illegible]	1873	[illegible]	[illegible]
1870	[illegible]	[illegible]	1874	[illegible]	[illegible]
	[illegible]	[illegible]		[illegible]	[illegible]

It will be noticed that while there was an increase of fifty-one in the number of fires during the four years in which Holly has been in use, over the corresponding period when steam engines were relied upon for fire suppression, the grand result is that HOLLY WORKS CUT DOWN THE AGGREGATE LOSSES TO LESS THAN ONE-THIRD WHAT THEY WERE BEFORE IN A CORRESPONDING PERIOD.

The same thing is true everywhere when Holly Works are substituted for movable engines for putting out fires.

Holly Water Works Reduce Insurance.

This results because when Holly Works are introduced, fires are promptly suppressed, and losses of property largely diminished. The underwriters in Lockport, Auburn, Buffalo, and many other places, have certified to this effect in the strongest terms, and the saving in premiums is generally equal to a large proportion of the original cost of the works, while the insurers at the reduced rates make more money, because the losses they have to pay are proportionately reduced. In Peoria, Illinois, J. C. Hassel, an insurance agent, puts the average reduction at 50 per cent. In Binghamton, N. Y., the reduction is officially put at 33⅓ per cent. In Ogdensburgh, N. Y., it is argued that the aggregate reduction in insurance rates would in three years be equal to the cost of the water works complete. In Kalamazoo, Michigan, it was estimated on good authority, that reduction in insurance rates would in two years equal the aggregate outlay for the construction of the Holly Works.

In Rochester, N. Y., after a year's trial, Mayor Clarkson in his address to the Council, April 1, 1875, says:

"Of the Holly Works, it may be said they have already justified full expectation, in the security and protection which they afford against the devouring and

destructive element, fire, AND IN THE REDUCED RATES OF INSURANCE. It is generally felt, however, that these rates are yet much too high, and further reductions will have to be made in all to satisfy insurers."

Simultaneous with this testimony of Mayor Clarkson, the Board of Water Commissioners made their report, in which they state:

"The amount of annual premiums paid on fire insurance policies in the city of Rochester before the introduction of water works, was not far from $[illegible]. Fully three-fourths, if not seven-eighths of the insurable property in it is now protected by the water works. As a natural consequence, the fire insurance companies, recognizing the fact, at once reduced the rates of insurance, but only to the amount of twenty per cent. This reduction has not been looked upon by the owners of property as sufficient, in view of the entire want of proper protection against fire before the introduction of water works, and the remarkably perfect protection which is now afforded. The great majority have, therefore, taken the responsibility to assume more risk themselves, and largely reduce the amounts of their policies—some as high as one-half or even more, while there are few who have not reduced at least twenty per cent. It may therefore be fairly stated that *the average reduction of risk has been at least twenty per cent.* But for our purpose, we will assume that the total reduction in rates and amount of risks has been equivalent to a saving of forty per cent. on the amount of the premiums heretofore paid. If we assume, besides, that $[illegible] was the amount of premiums formerly paid upon property embraced within the protection of the water works, the actual SAVING EFFECTED, THUS, WOULD BE $[illegible] PER ANNUM.

The city is entitled to much further reduction in fire insurance rates. It is now the best protected city in [illegible] in the United States, and the [illegible] which its [illegible]."

Want of space forbids the insertion of similar statements which prove that Holly Works more than pay for themselves in diminished insurance rates, aside from their inestimable value in other important particulars.

As in Rochester so everywhere, the introduction of Holly Works saves the owners of property, in the reduction of insurance rates, an amount equal to the payment of taxes for the construction of the works, and this of itself, and independently of other considerations, is a strong argument in favor of this great public improvement.

Holly Water Works Curtail Fire Department Expenses.

These expenses are ordinarily very large and constantly increasing. In Boston, Mass., last year, with a population of [illegible], the sum of

$39,914.32 was raised by tax to meet fire department expenses, which is about equal to $2 for each man, woman and child within the corporation. In Cambridge, Mass., with population of about 40,000, the cost of the fire department for the year 1874 was $97,355, which is $2.43 for each inhabitant. In Providence, R. I., the fire department in 1874 cost that city the sum of $100,026.74. In Jersey City, N. J., there was spent in 1874, by the fire department, the sum of $136,946.84. These few examples fairly represent the enormous cost of the existing fire departments in connection with steam and hand engine service, and the excessive taxation which is necessarily imposed upon tax-payers. The cost of maintaining a steam engine, fully equipped and ready for efficient service, averages throughout the country about $7,500 per year. The introduction of Holly Water Works stops the purchase of new engines, which otherwise goes on steadily from year to year. It also disbands engine companies and devolves upon hose companies the management of fires. In consequence steamers are disposed of, and their great annual cost saved to communities. It is entirely safe to say that while Holly Works give much better protection to property from the ravages of fire, it also reduces fire department expenses to not more than one-half their cost where they include steamers in use in connection with gravitation works.

Why Gravitation Works cannot be Relied upon to throw Fire Streams.

It is sometimes claimed that since "pressure is pressure," gravitation water works are just as good as Holly, if the reservoir or stand-pipe is placed at the proper elevation. This is true, but the difficulty is that a fixed elevation cannot be made to provide for variations of pressure which are requisite for both daily supply and fire streams. In regard to both Reservoir and stand-pipe, "if they are high enough to give the necessary pressure for fire purposes, they are quite too high for the ordinary delivery of water. If they are low enough for ordinary delivery, they are entirely unfit for fire purposes. The one requires a pressure of about forty pounds to the inch, the other not less than eighty."

In order to make plain the differences and advantages of Holly's plan, and to show that it overcomes this inherent defect of gravitation works, take for illustration the stand-pipe works at Erie, Pa., and the Holly Works in Bay City, Michigan.

The stand-pipe at Erie is 217 feet high, and the builder of it states that it is the highest in the world. Gravitation pressure is in the ratio of a fraction less than 44 lbs. per 100 feet of elevation. Hence at the foot of the stand-pipe in Erie there is an available pressure of 95 lbs., and this pressure is modified and diminished in its application to the distribution of water throughout Erie by two influential causes, viz: friction and the varying draughts of water from the distributing pipes. Thus, while under no circumstances can the pressure be increased above 95 lbs. at the base of the stand-pipe, it is liable to be reduced to half or even less than half that amount in certain parts of the area of water distribution,—and, what is worse—owing to irregularity of draughts of water from the pipes, no one can tell what the pressure will be at a definite future time in a particular point or points of the street mains. Owing to this inherent and incurable defect, there is not a community in the land, with reservoir or stand-pipe works, that dare rely on them for fire-stream pressure. They deem themselves fortunate if the stand-pipe or reservoir pressure yields water for the supply of the movable engines which are required as an indispensable auxiliary.

Now contrast this with the Holly Works at Bay City, which are a type of similar works elsewhere. In the public trial of them recently six powerful streams were thrown from a line of hydrants 2¾ miles from the machinery. During the display the water pressure ranged at the works from 120 to 150 lbs. The connecting line of pipe was through 14, 12 and 10 inch mains, and friction diminished the pressure at the point of the fire streams not less than 50 lbs., leaving from 70 to 100 lbs. available at the hydrants in use. To produce the same result with stand-pipe or reservoir pressure, would require it to be carried up to a height of 340 feet!! The Erie stand-pipe, the highest in the world, would only have supplied, at the most, but 45 pounds for fire streams at the distance of 2¾ miles from the works at Bay City, and this would be subject to a further reduction when daily supply set in and draughts from the mains were made for that purpose. To make good the assumption that the stand-pipe works will furnish pressure equal to Holly's direct pumping plan, involves either the erection of a stand-pipe or reservoir 340 feet high, or a change in the law of gravitation which yields pressure in the ratio of 44 pounds per 100 feet of elevation. In view of these incontrovertible facts, it is not surprising that the committee of the Mansfield (Ohio) council made report, after thorough

examination of the various modes of water supply, "that in all the places we visited where gravitation works were in use, we found that movable engines were regarded as a necessity. While in those communities having the Holly direct pumping system, the movable fire engines are dispensed with, and regarded as unnecessary, within the range of the hydrants."

Holly has a Majority over Gravitation in Twelve States.

In May, 1874, the Firemen's Association of the Northwest held its fifth annual meeting in Louisville, Ky. The organization embraces the twelve States of Ohio, Indiana, Illinois, Missouri, Wisconsin, Kansas, Kentucky, Minnesota, Nebraska, Michigan, Iowa, and Colorado. Mr. J. B. Vance, chairman of a committee appointed for that purpose at the last annual meeting, read an extended report on the subject of "Fire Departments and Water Supply" in these twelve States, by which it appeared that there was within their bounds—

Cities and villages having Holly Water Works	38
" " " " Reservoir "	28
" " " " Stand pipe "	3

Showing 7 majority for Holly over both kinds of gravitation works. When it is considered that the construction of gravitation works has been going on for centuries, and that Holly's new plan has within half a dozen years outstripped both reservoir and stand pipe works in twelve States, is conclusive proof of superiority and popularity. In a short time Holly Works will be in a majority in all the States of the Union.

Crowning Proof of the Merits of Holly's Water Works System.

This is found in the fact that in several instances parties are striving to imitate the plan which Mr. Holly has devised, perfected and secured to himself and associates in the Holly Manufacturing Company by numerous letters patent. It is alleged that this may be done without incurring legal liabilities for patent infringement, because Holly's plan is not new, but was in use in London some three hundred years ago. In this statement reference is made to water works devised by one Peter Morice, and put in operation in 1582. A volume published by

John Stow, in the year 1631, entitled "Annals, or a General Chronicle of England," on page 694, describes in the following words these works of Peter Morice:

"This year Peter Morice, a Dutchman, but a free denizen, having made an engine for that purpose, conveyed Thames water IN PIPES OF LEAD OVER THE STEEPLE OF ST. MAGNUS CHURCH at the north end of London Bridge, and so into divers men's houses in Thames street, New Fish street and Grace street, up into the northwest corner of London Hill, (the highest ground in the city of London,) where the most of the first main pipe ran first this year 1582 on Christmas even; which main pipe being hence at the charges of the city BROUGHT UP INTO A STANDARD THERE MADE FOR THAT PURPOSE and divided into four several spoutes ran four ways, plentifully serving to the use of the inhabitants near adjoining that will fetch it, and also cleanse the channel of the street north towards Bishop's Gate, east towards Algate, south towards the Bridge, and west towards the stock market; no doubt a great commodity to that part of the city, and would be far greater if the said water was maintained to run continuously, or at the least at any time some reasonable quantity, as at the first it did."

In a volume entitled "Philosophical Transactions for the year 1731," Mr. Beighton, an engineer, gives an elaborate description of the works of Peter Morice, which had been in operation since 1582, as mentioned by Mr. Stow in the above extract from his "Chronicles." He states that the pumps were driven by water wheels, and "whenever the pistons of the pumps ascended, the water was forced along the bent pipes INTO THE UPPER CISTERN, FROM WHICH A LARGE PIPE CONDUCTED IT TO SUPPLY THE HOUSES."

The corporation of London gave a lease to Peter Morice, authorizing him to operate his works as above described, and this lease and business of water supply remained in the Morice family until the year 1701, when it was sold to Richard Soames for the sum of £38,000." Mr. Soames formed a chartered company, which operated the works until they were absorbed into another organization on a larger scale, and the original works of Peter Morice were abandoned and destroyed. The volume entitled "Hydraulia; Water Works of London," &c., by W. Matthews, published in London in 1835, by Simpkins, Marshall & Co., on pages 38 and 39 gives the following cogent reasons why these works of Morice went out of use:

"Admirable as might be the London Bridge Works for the ingenuity displayed in their original contrivance and construction, nevertheless, they eventu-

ally became incompetent to effect some desirable purposes required by the progressive introduction of various improvements. The principal of these arose from building many houses in the city very lofty, and furnishing the rooms in different stories, even to the highest, with washing and other conveniences. As a plentiful supply of water was essential for the use of each, to convey it to the height of some of them, rendered indispensable the aid either of VERY ELEVATED RESERVOIRS, or more powerful machinery than that possessed by the London Bridge Works. But the low state of their funds prevented the proprietors from contemplating the attainment of such costly objects; and if a deficiency of pecuniary resources had not proved an insuperable impediment to their desire of making necessary improvements, there existed a very great difficulty, if not an almost impossibility, of PROCURING PROPER SITES FOR THE CONSTRUCTION OF RESERVOIRS, or the erection of large engines. Besides, even if they could have obtained the situations best adapted to that purpose, from their being probably covered with buildings, the amount of the purchase would consequently be so enormous as to make the attempt on their part unavailing."

The above quotations from standard works show how unfounded and preposterous is the pretence of similarity between the works of Peter Morice and the plan of Birdsill Holly. Morice pumped into cistern or cisterns and gravitation conveyed the water to consumers. The force pump had just then been invented, and to show that by this new motive power he could lift water into cisterns, a lead pipe was run up to the top of St. Magnus steeple, and water forced through it and made to flow out at the upper end. There was no throwing of fire streams direct from hydrants—indeed there were no hydrants in use, or even hose or engines. There was no pumping into closed pipes with contrivances for regulating pressure, which is the great feature of Holly's plan, but daily water supply was provided for by pumping water into open receptacles from which by gravitation the flow to the customers was secured. Peter Morice's "standard," and "cisterns," were but types of the stand-pipes and reservoirs of the present day, and do not present a single feature of resemblance to the plan of Birdsill Holly. The pretence, however, that Holly was an imitator of Peter Morice, has emboldened certain parties to construct direct pumping works, in defiance of the legal rights granted to him and his associates under the patent laws. Suits have been instituted on this account against Rahway, N. J., and Union City, Ind., which are being prosecuted to an issue with all possible despatch. Numerous other localities, which are guilty of infringements, will be held to a strict accountability.

ASTONISHING FIRE STREAM DISPLAY IN ROCHESTER.

As preliminary to acceptance of water works machinery, it has been customary for the Holly Manufacturing Co. to make public tests of capacity for throwing fire streams direct from hydrants. These public trials always attract large crowds of interested and enthusiastic observers. A single one of these trials is selected for insertion in this pamphlet. It was made in Rochester on the 18th of February, 1874, and the following abbreviated description of it is from the *Union and Advertiser* of that city:

The Exhibition.

"The programme for the official and public test of the Holly system as previously published in the *Union*, was carried out to the letter. At half past one o'clock P. M., the hosemen from the several engine and hose companies, under the direction of Chief Engineer Gibson of the Fire Department, stretched hose from the hydrants in Main street, and stood ready for the first tap of the City Hall bell, that should announce the pressure to be put on for the first test.

TWELVE STREAMS.

"At two o'clock precisely Mr. John T. Fox, from his store by the fire alarm telegraph, sounded one blow on the Hall bell, and in less than half a minute thereafter, twelve one-inch jets were shooting into the air from hydrants between Plymouth avenue and Clinton street, as follows:

LOCATION OF HYDRANTS.	No Hydrant.	Side of River	No. of Streams thrown from Hydrant.
Southeast corner St. Paul and East Main streets......	19	East	1
Northwest corner St. Paul and East Main streets......	18	East	1
Northwest corner Liberty alley and East Main street..	17	East	1
Southeast corner Water and East Main street.........	16	East	1
Northwest corner Front and West Main streets.........	15	West	1
Southwest corner Aqueduct and West Main streets....	14	West	1
Southeast corner Exchange and West Main streets....	12	West	2
Southwest corner Exchange and West Main streets....	11	West	2
Southeact corner School alley and West Main street..	6	West	1
Northeast corner Sophia alley and West Main street...	5	West	1
Total..............................	......	....	12

"The pressure was then slowly raised, and when the climax was reached and each and every stream shot far above the roofs and towers of surrounding buildings, doubters and unbelievers were silenced. The firemen contented themselves with the idea that when the twenty and thirty stream tests were made they would have a chance to scoff.

EIGHT ADDITIONAL STREAMS.

"Another tap on the bell was the signal for the opening of eight additional streams, and twenty streams of water were shooting into the air. The first twelve did not appear to be diminished in height, but all averaged nearly alike in that respect. The following are the eight additional streams:

LOCATION OF HYDRANTS.	No. Hydrant.	Side of River.	No. of Streams thrown from Hydrant.
Stand pipe from roof of Osburn House..............	20	East	1
Stand pipe from roof of Powers' block...............	10	West	1
Southeast corner Irving place and West Main street...	9	West	2
Northeast corner Fitzhugh and West Main streets.....	8	West	2
Southeast corner Fitzhugh and West Main streets.....	7	West	2
Total..	......	....	8

"These twenty streams complied with the contract test. The following observers were stationed at different points in the street and took the different altitudes to which the streams were thrown.

"L. L. Nichols, Assistant Engineer Rochester Water Works.

"Byron Holley, Assistant Engineer New York State Canals.

"Thomas Evershed, Chief Engineer Rochester and Nunda Railroad.

"John Cowman, Civil Engineer and Surveyor.

"Cyrus Beardsley, Assistant Engineer and Surveyor.

"Daniel Drummond, with assistant, Engineer and Surveyor.

"John Ryan, Assistant City Surveyor.

"John Fitch, Engineer and Surveyor.

"They reported that the fourteen one inch streams were thrown an average height of one hundred and thirty-five feet, or *thirty-five* beyond the contract requirement.

THIRTY STREAMS.

"Another signal, and Main street presented the appearance of having a solid body of water suspended over the roofs of the buildings. The water as it fell in big drops or spray presented a beautiful sight. The sun was shining brightly and magnificent rainbows were seen at the street corners. The observers reported that these thirty streams averaged 135 feet in height. This exhibition capped the climax, and many who had doubted were now inclined to the belief that there was some necromancy in the affair. Every one, when two signals were given for the pressure to be removed, declared himself satisfied and thought the rest of the advertised exhibition was not necessary—Rochester had the best water works in the world.

THE TWO-INCH STREAM.

"Precisely at ten minutes past three the signal for turning on the two inch stream was given, and in a few moments a stream sprang forth, and after playing for a short time rose to the height of the Court House. The spectators were all breathless with expectation to witness if the stream would reach the

statue of Justice surmounting the lofty dome. A loud burst of applause greeted the accomplishment of a feat that had seldom been obtained, and a still louder roar was heard when the glittering stream, which seemed to gather additional force as it rose, shot fully thirty feet above it. At this exhibition even the most skeptical were obliged to acknowledge the triumphant success of the exhibition. Horace Silsby, one of the manufacturers of the Silsby steam fire engines, who with some of his friends was a witness to this transaction, was heard to exclaim 'that he would not have believed it possible, unless he had personally witnessed it, that such a large stream of water could be thrown to such a height, and that when he gave them the account of it at home they would not believe him.' No greater compliment than this could be paid to the Holly system.

"After continuing this magnificent stream for a period of ten minutes, the signal sounded to turn the water off. A large iron standard, placed in the street near the northwest corner of the building, and held in its place by half a dozen strong men, was used as a support for the hose, which was run from three hydrants and attached to a discharge pipe by a triplicate coupling. The officers of the Holly Works must have felt a thrill of exultation run through them as the assembled multitude sent up such a spontaneous tribute to the grand success of their undertaking.

THE FOUR-INCH HORIZONTAL STREAM.

"Those who had been quietly informed what was expected of the four-inch horizontal stream thrown from a stand pipe in front of Powers' Building, and located near the State street crosswalk, were anxious for the signal to be given that should either elate or depress the originators and contractors of the scheme. A large number of prominent insurance men from abroad, with Mayor Aldridge, Fire Marshal Angevine, and proprietors of home agencies, were on the roof of Powers' building, where they had a splendid view of all that was taking place. Mayor Aldridge suggested that a little 'guessing' be indulged in. He guessed the stream would be thrown about 250 feet; others thought 80 feet reasonable. One green chap, who thought he knew what he was about, made a wager that the water would not reach a point in the street opposite the centre of the City Hall. The signal was given, and in a minute the water commenced flowing from the pipe. It gradually extended, and when it reached about fifty feet distant it seemed to be at a stand-still, and scores thought that was the maximum that would be reached. But the pressure was increased, and the stream sped westward across Irving place, past the point indicated above, and when the signal was given to shut off the pressure it had reached the crosswalk at the Rochester Savings Bank. The man who made the wager announced his intention to pay in case the stream did not reach the bridge over the canal in West avenue. Wonder was on every countenance. People were dumb; they had witnessed the greatest exhibition of hydraulics ever made.

"The Underwriters held a sort of impromptu meeting, when one of them suggested that it be resolved that the citizens of Rochester did not need any more fire insurance—*marine* insurance was what they were in need of at present. The exact distance this body of water reached—not spray—was *four hundred and sixty-five feet.* The gutters were filled with water—were overflowed, the sewer openings not being of sufficient capacity to carry it off.

THE THREE-INCH VERTICAL STREAM.

"The tap of the bell sounded at [illegible] P. M., and the horizontal stream was cut off and the delivery pipe raised to a vertical position. At this point the enthusiasm of the spectators had risen to almost fever pitch, and bets were freely offered on the height to be obtained by this stream. The tower and windows of Powers' Block were densely crowded, and an eager, expectant look was observable on most of their countenances, and notwithstanding the drenching shower of spray that the wind carried over the building, they defied colds, rheumatism, and every other ailment that cold water is popularly supposed to inflict on people, in order to see the result of this immense flow of water. At the signal the water was let on, and the stream gradually rose higher and higher, until it obtained the immense altitude of [illegible] feet. The delight of the spectators when this height was reached was manifested in the deafening and prolonged cheers that greeted the undertaking.

THE FOUR-INCH VERTICAL STREAM.

"After playing the allotted time the three inch stream was turned off, the nozzle was unscrewed, and a flush cap adapted for a four inch delivery was fixed in its place. Some little time was occupied in making the change, but soon another stream of four inches in diameter was seen gradually ascending until the unprecedented height of [illegible] feet was reached. After playing its allotted time it was turned off and the mouthpiece removed for the

FIVE INCH VERTICAL STREAM.

"This was the crowning feat of the exhibition. That any one of the spectators was sanguine enough to believe that a stream of water five inches in diameter could be thrown to a height of [illegible] feet, before they were eye witnesses of the fact, is not to be credited. The height of this immense stream can be comprehended when it is said that it reached over fifty feet higher than the eagle on the top of the flag-staff on Powers' Block. Some large stones of the size of a man's fist had by some means got into the pipe, and were ejected into the air a considerable height above the surrounding buildings. The amount of pressure put on to throw this stream, was only [illegible] pounds to the square inch; and the chief engineer says he is fully confident that it could just as easily have been thrown [illegible] feet as [illegible] feet. The signal for the termination of the exhibition was given at [illegible] P. M., and the pressure turned off, thus closing one of the grandest displays of the power of water, supplemented by machinery, ever seen in the world."

DUTY TESTS OF HOLLY WATER WORKS MACHINERY.

Compelled to concede the merits of Holly Plan of Water Works, interested parties have sought to disparage and excite prejudices against Holly Machinery, on the pretence that it does not work economically in the duty performed. To meet and refute these

charges, careful tests have been made in Rochester, N. Y., and Evanston, Ill., of two sizes of Holly's Pumping Engines, and the statements in each case are herewith submitted:

As preliminary it is thought advisable first to insert a

Description of the Rochester Holly Engine.

The engines at Rochester consist of four steam cylinders, 16 x 26.9 inches, placed upon a heavy arched iron frame, two on each side inclined to each other at an angle of 90°, so that no two are taking steam at once. The piston rods extend through the lower heads of the steam cylinder, and are coupled to the pump rods below, so that one, two, three or four pumps can be used at once.

The pumps are 9.98 inches in diameter, and 26.9 inches stroke, and the four deliver at the one revolution of the engine, 71.28 gallons of water, or 594.33 pounds. This set of machinery will pump three million gallons of water in twenty-four hours, when running at the rate of thirty revolutions per minute.

This was the fifth engine constructed on the compound principle, and this plan was devised expressly for duty. As will be seen, most of the tests were made with the engine running in this way, and with by far the best results. We do not expect this will be taken as a true comparison between compound and single cylinder engines, but to show the difference between running this particular one, compound or direct.

The steam is not allowed to follow full stroke in the first cylinder, as the variable cut-off is operated by the pressure regulator, which admits the least possible steam that will furnish the power necessary to supply the water being used throughout the city, for fires or other purposes. In the low pressure cylinder the steam is also cut-off at a point that produces the best results from expansion.

The air pump is driven from the crank-pin of the engine, and consists of two single acting cylinders, the piston of one ascending, while the other is descending. The bottom of this pump connects directly to a jet condenser, and from the hot-well the boiler feed-pumps take suction. The discharge pipe leading to the boilers from the feed pumps passes through a live steam heater, thus supplying feed water at a high temperature.

The boiler used was a plain horizontal one, five feet shell and sixteen feet long, having 54 3$\frac{5}{8}$ inch flues, and is set in a brick arch.

The steam jacket pipe, cut off cases, and considerable of the steam pipe was not covered with a non-conductor at the time these tests were made. The engine had not been used for three months previous, as it is held as a reserve—the principal power being furnished by water.

Taking the fact into consideration, that an engine made to pump a constant quantity against an unvarying head may be constructed so as to give high duties, these results may be considered as remarkable as this engine was built to work against varying heads of water, (from twenty-five feet up to four hundred feet,) and at all speeds, (from four revolutions per minute up to forty). The speed is constantly changing as the quantity of water being used is more or less.

The height to which the water is pumped, is at all times under the control of the engineer, so that in case he receives an alarm of fire, the pressure can be instantly raised sufficiently to throw powerful fire streams directly from the hydrants.

These engines can be used condensing, non-condensing, or compound, the object of these different changes is to produce a machine adapted to a wide range of work, one that can be run with economy, while pumping for domestic supply, and which can in case of a fire be quickly converted into a powerful steam fire engine.

Manner of Conducting the Tests.

Before beginning each test, the engine was stopped, the steam pressure and height of water in the boiler noted, the fire was then drawn from the grates, and all ashes raked out, a new fire was then built with all the fuel carefully weighed.

At the end of the test, the engine was stopped with the steam at the same pressure as at the beginning; and the water in the boiler at the same height, as shown by the glass water gauge. The revolutions were counted by two counters, and they were turned back before beginning each test.

The height to which the water was raised was determined by two Ashcroft's Water Gauges, and the pressure was kept uniform by the regulator. The varying domestic supply was pumped, besides enough water was allowed to escape through a water safety-valve to bring the engine up to the speed desired. The pumps were examined at short intervals to ascertain if there was any lost action caused by the presence of air, and in no case during a test was there any to be

detected. Fig. 8 shows an indicator card taken from the pump with air admitted purposely. Fig. 7 shows one taken when the pump was delivering its full content of water; and in all cases during tests, diagrams were obtained corresponding to this

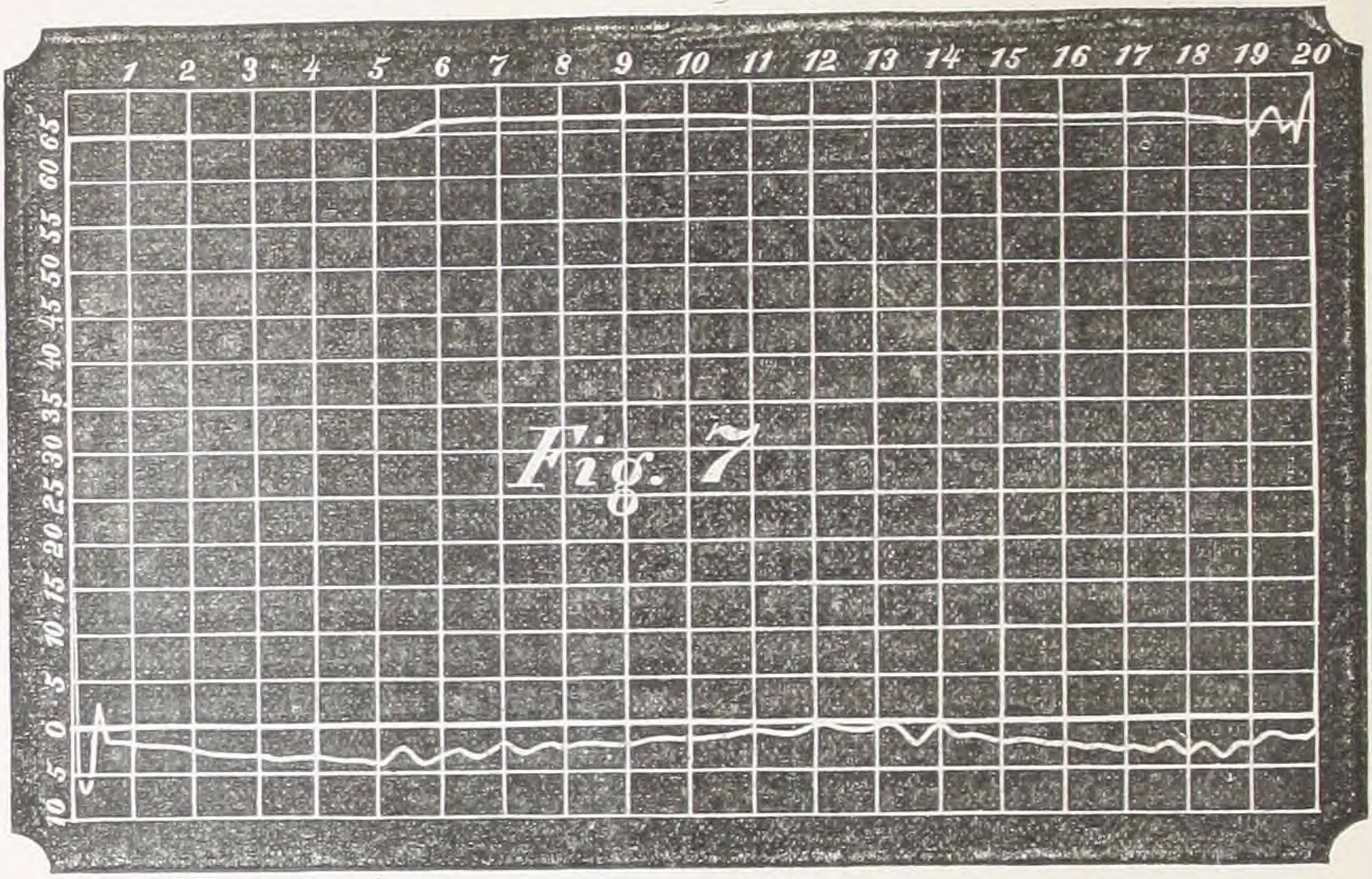


Fig. 7

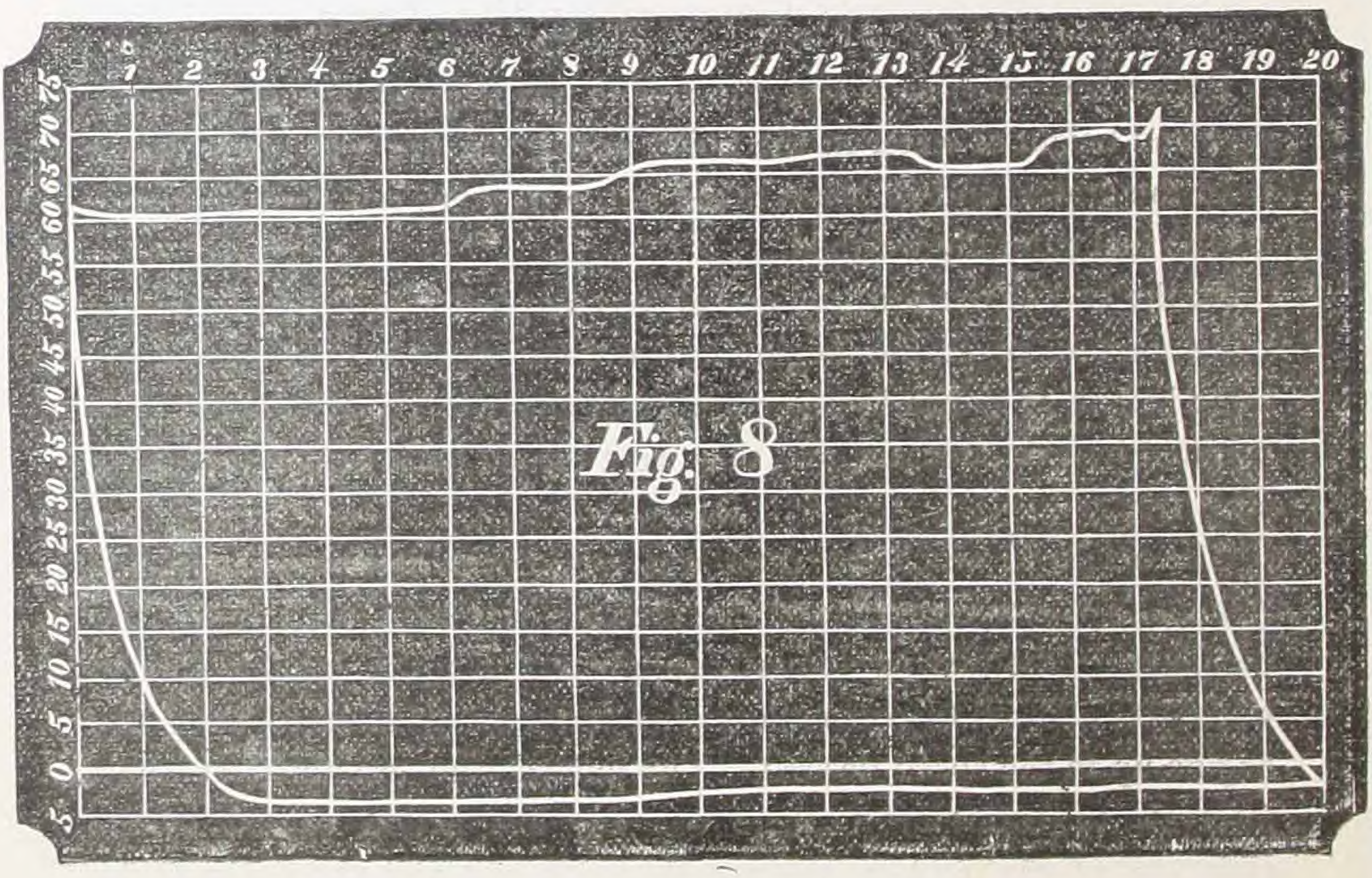


Fig. 8

TEST No. 1.

ROCHESTER, *June 26th*, 1874.

Engine run compound, steam in the jacket.

Duration of Test—two hours and forty-five minutes.

Revolutions of engine	2900
Average Revolutions per minute	17.57
Water cylinder connected	2
Diameter of pump piston in in.	9.98
" " " rod " "	2.187
Length of Stroke " "	26.937
Mean height water was pumped in feet	134
Distance of center of gauge from surface of water in pumping well in feet	18
Coal charged to the boiler in lbs., (bituminous)	131
Coal and ashes left in lbs.	2000
Duty in foot-pounds, from 100 lbs. of coal, deducting the coal and ashes left	[illegible]

TEST No. 2.

ROCHESTER, *June 26th*, 1874.

Engine run compound, steam in the jacket.

Duration of Test—one hour and thirty minutes.

Revolution of Engine	[illegible]
Average revolutions per minute	14.77
Water cylinders connected	4
Mean height water was pumped in feet	134
Coal charged to the boiler in lbs., (bituminous)	[illegible]
Coal and ashes left in lbs	[illegible]
Duty in foot-pounds, from 100 lbs. of coal, deducting the coal and ashes left	56,500,000

TEST No. 3.

ROCHESTER, *June 27th*, 1874.

Engine run compound, steam in the jacket.

Duration of Test—five hours and forty minutes.

Revolutions of engine	8823
Average revolutions per minute	25.95
Water cylinders connected	4
Mean height water was pumped in feet	134
Coal charged to the boiler in lbs., (anthracite)	1731
Coal and ashes left	450
Duty in foot-pounds, from 100 lbs. of coal, deducting the coal and ashes left	63,054,000

TEST No. 4.

ROCHESTER, *June 29th*, 1874.

Engine run compound, steam in the jacket.

Duration of Test—eight hours.

Revolution of engine	13200

Average revolutions per minute	27.5
Water cylinders connected	4
Mean height water was pumped in feet	154.174
Coal charged to the boiler in lbs., (anthracite)	2231
Coal and ashes left in pounds	420
Good Coal in above, fit to burn	200
Duty in foot-pounds, from 100 lbs. of coal, deducting the coal and ashes left	66,787,000
Duty deducting only the coal fit to burn	59,553,000

TEST No. 5.

ROCHESTER, *June 30th*, 1874.

Engine run compound, steam in the jacket.

Duration of Test—two hours and thirty minutes.

Revolution of engine	4403
Average revolutions per minute	29.35
Water cylinders connected	2
Mean height water was pumped	154
Coal chargsd to the boiler in lbs., (bituminous)	531
Coal and ashes left	172
Good coal in above, fit to burn	90
Duty in foot-pounds, from 100 lbs. of coal, deducting the coal and ashes left	56,127,000
Duty deducting only the coal fit to burn	45,690,000

Figs. 4 and 6 show diagrams taken from the steam cylinders while running compound, with only two pumps connected, as in the fifth test. The card shown in Fig. 5, was taken with the cut-off valve open during the whole stroke.

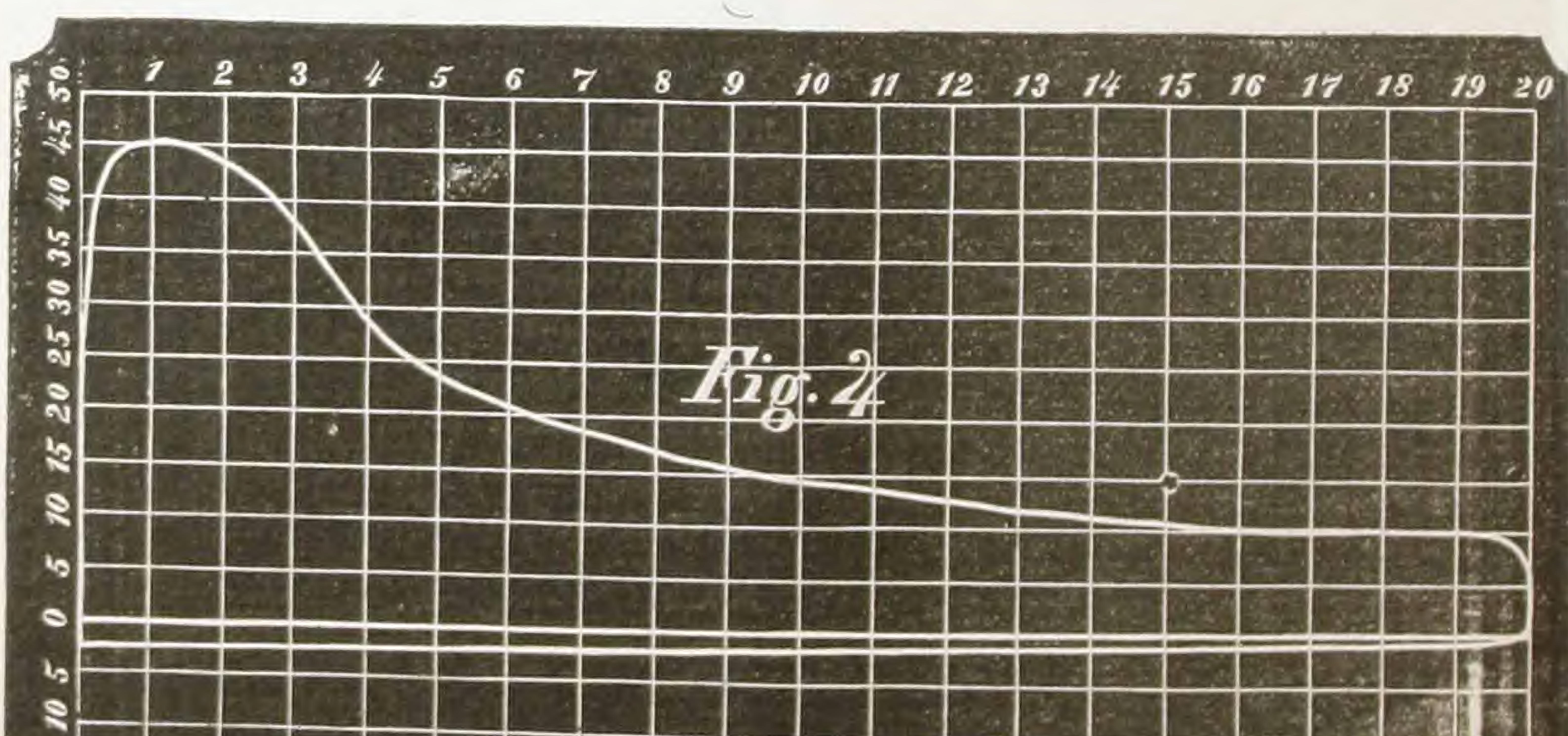


Fig. 4

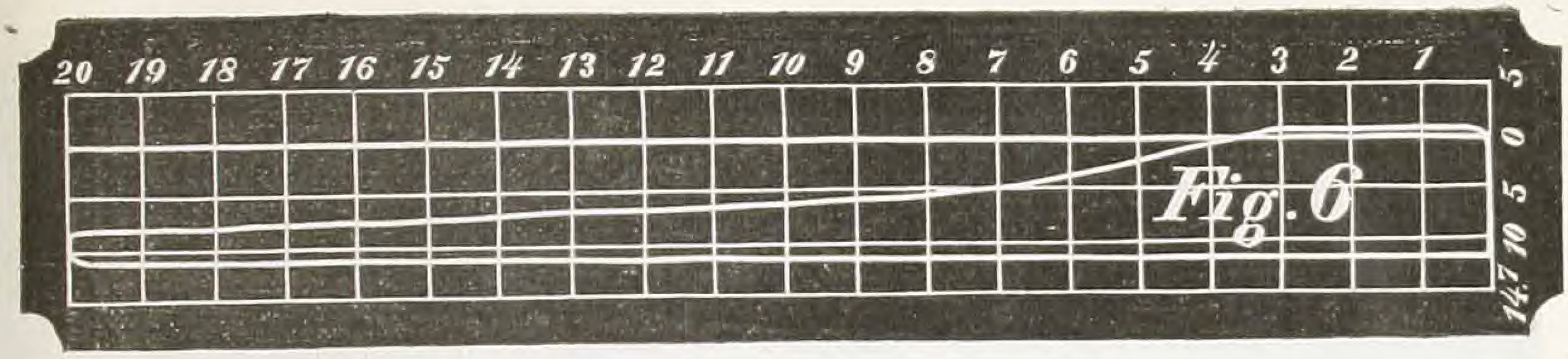


Fig. 6

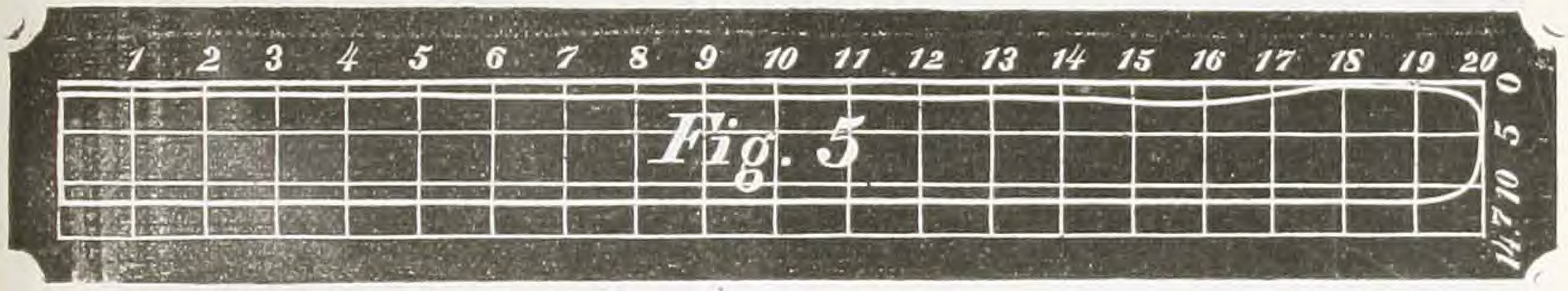


Fig. 5

TEST No. 6.

ROCHESTER, *July 1st*, 1874.

Engine run compound, steam in the jacket.

Duration of Test—one hour and thirty-eight minutes.

Revolution of engine	2372
Average revolutions per minute	24.2
Water cylinders connected	4
Mean height water was pumped in feet	154
Coal charged to the boiler in lbs., (bituminous)	531
Coal and ashes left in lbs	193½
Duty in foot-pounds, from 100 lbs. coal	64,326,000

Figs. 1 and 2 show diagrams obtained in the above test.

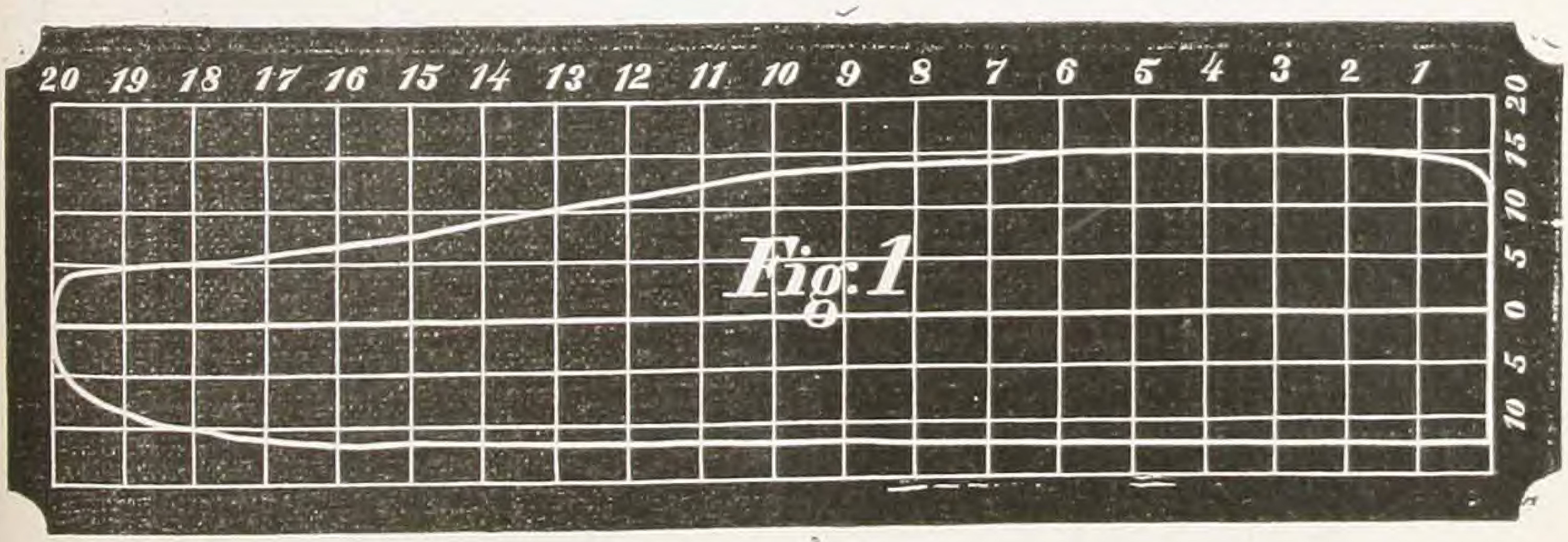


Fig. 1

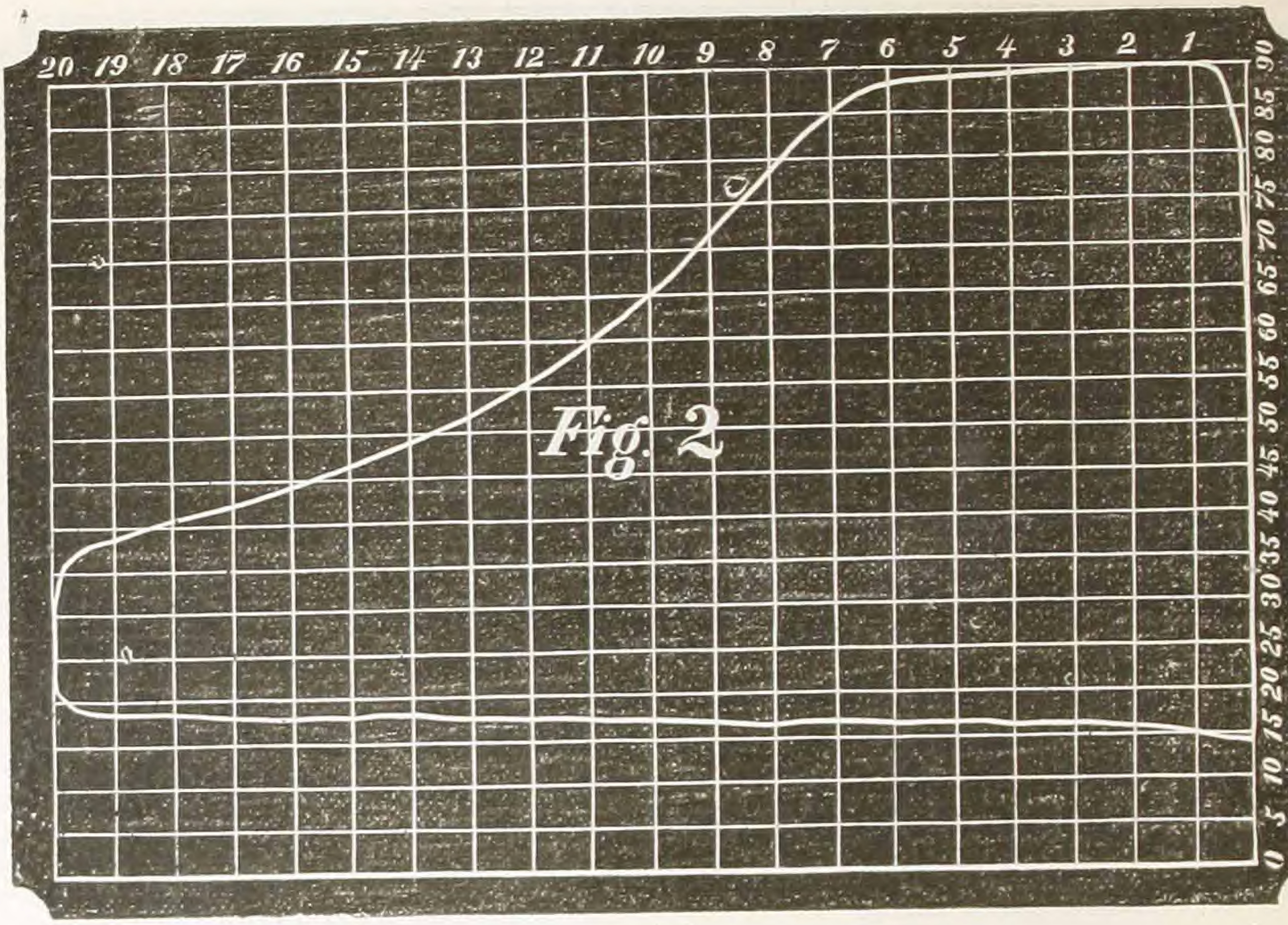


Fig. 2

TEST No. 7.

ROCHESTER, *July* 1st, 187.

Engine run compound, no steam in the jacket.

Duration of Test—one hour and fifteen minutes.

Revolutions of engine	1953
Average revolutions per minute	26.04
Water cylinders connected	4
Mean height water was pumped in feet	154
Coal charged to boiler in lbs., (bituminous)	531
Coal and ashes left in pounds	224
Duty from 100 pounds, coal in foot pounds	58,225,000

TEST No. 8

ROCHESTER, *July* 1st, 1874.

Engine run compound, steam in the jacket.

Duration of Test four hours.

Revolutions of engines	6330
Average revolutions per minute	26.37
Water cylinders connected	4
Mean height water was pumped in feet	154
Coal charged to the boiler in lbs., (bituminous)	1231
Coal and ashes left in pounds	371
Duty in foot-pounds, from 100 lbs. of coal	67,368,000

TEST No. 9.

ROCHESTER, July 2d, 1874.

Engine run compound, no steam in the jacket.

Duration of test—3 hours and 38 minutes.

Revolutions of engine	6134
Average revolutions per minute	28.13
Water cylinders connected	4
Mean height water was pumped, in feet	152.97
Coal charged to the boiler, in pounds (bituminous)	1,231
Coal and ashes left, in lbs.	365
Duty in foot pounds, from 100 pounds of coal	64,377,000

TEST No. 10.

ROCHESTER, July 2d, 1874

Engine run compound, steam in jacket.

Duration of test—3 hours and 15 minutes.

Revolutions of engine	5,802
Average revolutions per minute	29.7
Water cylinders connected	4
Mean height water was pumped, in feet	154
Coal charged to the boiler, in pounds (bituminous)	1,031
Coal and ashes left, in pounds	264
Good coal fit to burn and cinders in the above	141
Duty, in foot pounds, from 100 pounds of coal, deducting the coal and ashes left	69,236,000
Duty, deducting only the coal and cinders left	59,869,000

TEST No. 11.

ROCHESTER, July 2d, 1874.

Engine run compound, no steam in the jacket.

Duration of test—4 hours and 20 minutes.

Revolutions of engine	6,365
Average revolutions per minute	24.48
Water cylinders connected	4
Mean height water was pumped, in feet	140.95
Coal charged to the boiler, in pounds (bituminous)	1,031
Coal and ashes left, in pounds	250
Coal and cinders in the above, in pounds	150
Duty in foot pounds, from 100 pounds of coal, deducting the coal and ashes left	68,271,000
Duty, deducting only the coal and cinders	60 524,000

TEST No. 12.

ROCHESTER, July 3d, 1874.

Engine run compound, steam in the jacket.

Duration of test—3 hours and 15 minutes.

Revolutions of engine	5,915
Average revolutions per minute	30.3

Water cylinders connected	4
Mean height water was pumped, in feet	154
Coal charged to the boiler, in pounds (bituminous)	1,051
Coal and ashes left, in pounds	310
Coal left	163
Duty in foot pounds, from 100 pounds of coal, deducting the coal and ashes left	75,087,000
Duty deducting only the coal left	62,315,000

TEST No. 15.

ROCHESTER, July 6th, 1874.

Engine run with steam direct from the boiler to the four cylinders, steam in the jacket.

Duration of test—1 hour and 45 minutes.

Revolutions of engine	2,328
Average revolutions per minute	22.03
Water cylinders connected	4
Mean height water was pumped, in feet	154
Coal charged to the boiler, in pounds (bituminous)	831
Good coal left, in pounds	180
Duty, in foot pounds, from 100 pounds of coal, deducting the good coal left	51,542,000

The following indicator card shows the action of the steam in the cylinders during this test:

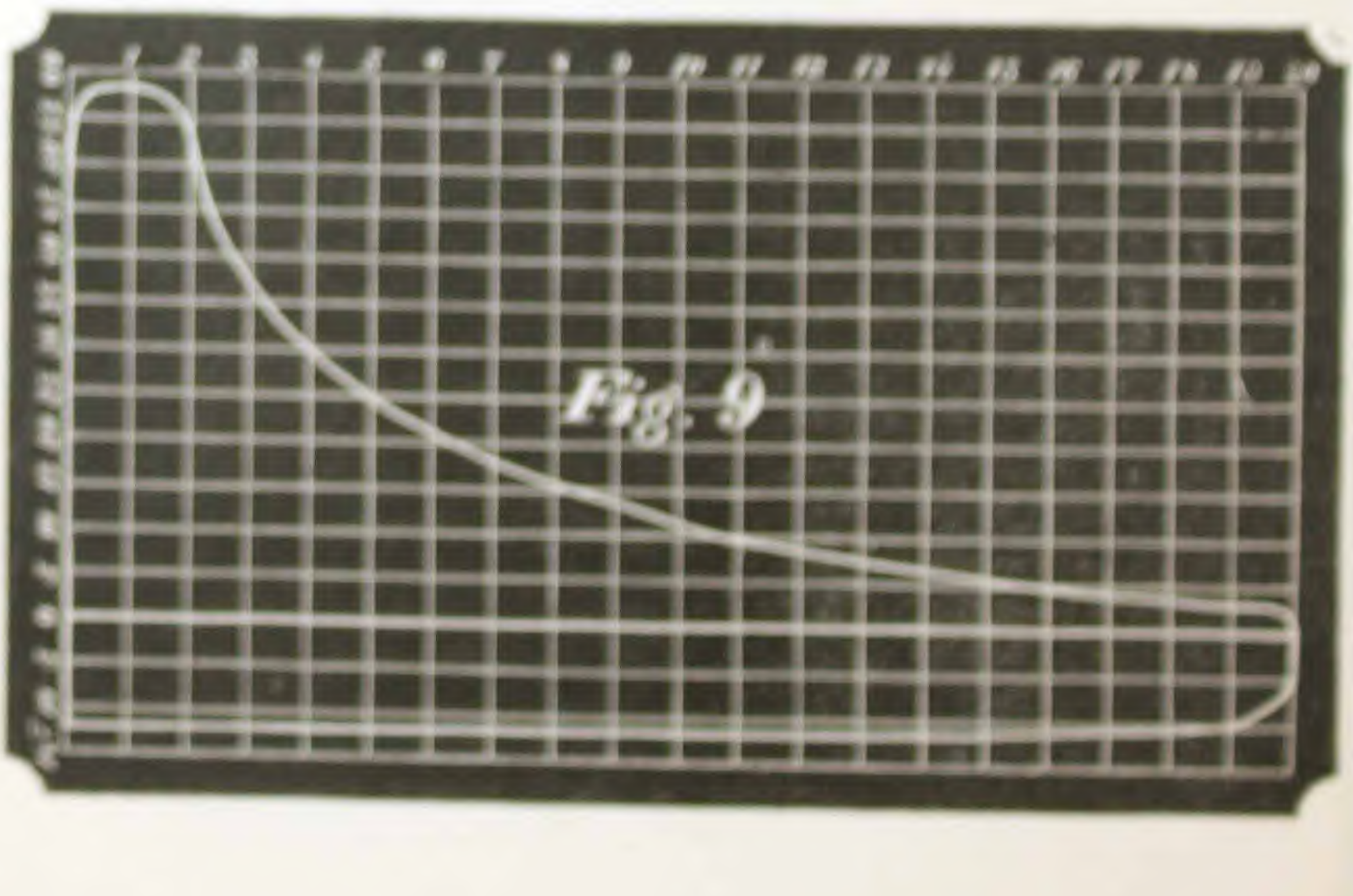


Fig. 9

TEST No. 14.

ROCHESTER, July 7th, 1874.

Engine run direct, steam in the jacket.
Duration of the test—2 hours.

Revolutions of engine	3,427
Average revolutions per minute	28.5
Water cylinders connected	4
Mean height water was pumped, in feet	154
Coal charged to the boiler, in pounds (bituminous)	1,031
Good coal left	129½
Duty, in foot pounds, from 100 pounds of coal, deducting the good coal left	34,793,000

TEST No. 15.

ROCHESTER, July 7th, 1874.

Engine run direct, no steam in the jacket.
Duration of the test—2 hours.

Revolutions of engine	3,055
Average revolutions per minute	25.4
Water cylinders connected	4
Mean height water was pumped, in feet	154
Coal charged to the boiler, in pounds	1,031
Good coal left	171½
Duty, in foot pounds, from 100 pounds ot coal, deducting the coal left	32,532,000

TEST No. 16

ROCHESTER, July 8th, 1874.

Engine run compound, steam in the jacket.
Duration ot test—4 hours and 30 minutes.

Revolutions of engine	6,517
Average revolutions per minute	24.1
Water cylinders connected	4
Mean height water was pumped, in feet	154
Coal charged to the boiler, in pounds	1,331
Coal and ashes left	320
Coal and cinders in the above	231
Duty, in foot pounds, from 100 pounds of coal, deducting the coal and ashes left	58,999,000
Duty, deducting only the coal	54,275,000

Fig. 3 shows a card taken while running direct, cutting off at about one-half stroke.

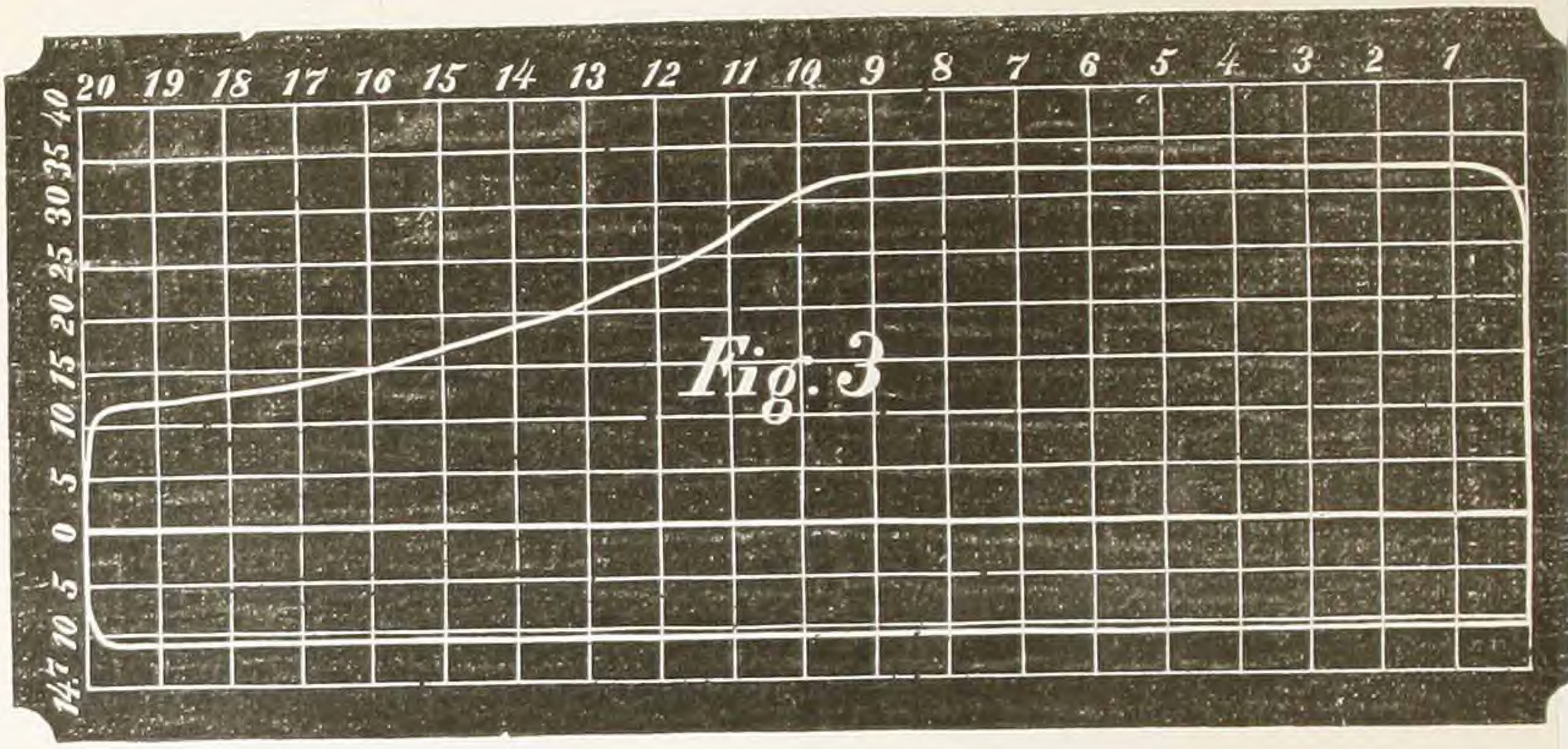
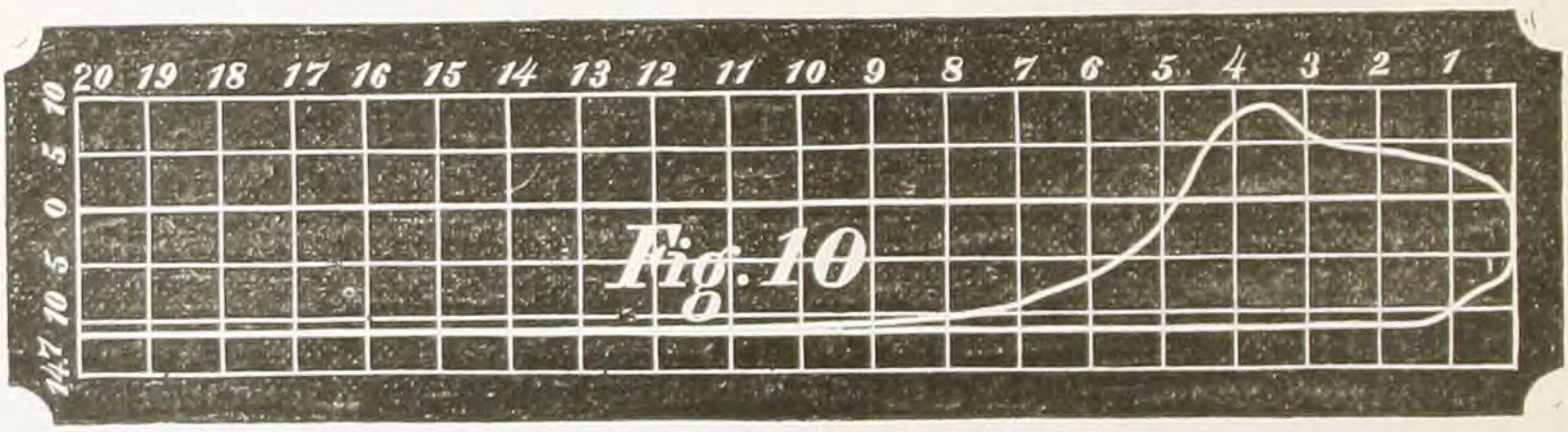


Fig. 10 is an engraving of a card which was taken from one of the air-pump cylinders.



The following is the report of the engineers appointed to superintend the making of duty tests on the part of Rochester:

J. Nelson Tubbs, Esq., *Chief Engineer Rochester Water Works:*

Dear Sir:—In accordance with your request, the undersigned were present at the duty tests of the engines of the Holly system in this city, on the 9th day of July, 1874.

Below will be found the results of our observations in tabular form.

The machinery in question consists of four inclined steam cylinders of sixteen (16) inches in diameter and twenty-seven (27) inch stroke, connected direct to four pumps, ten (10) inches by twenty-four (24) inches, located below the floor of the engine room. The steam cylinders were connected in pairs to opposite ends of the same crank shaft, and the steam pipes are so arranged that the exhaust from one cylinder may be admitted into the other three cylinders on the compound system, while from the latter communication is had with the con-

denser and air pump. At this trial steam was admitted to the high pressure cylinder at something over ninety pounds to the square inch, cut off at one quarter to one-half stroke, and exhausted into the compounding cylinders. The latter were steam jacketed, and the water of condensation was pumped back into the boiler together with the necessary quantity from the hot well, all of which is passed through a live steam heater, thus raising the feed water to a temperature somewhat above 212° Fahrenheit before its introduction to the boiler. The boiler is of the horizontal tubular variety, being the center one of a nest of three of the same size and construction. The steam pipe is covered with a non-conductor.

The fuel was one hundred pounds of hemlock kindlings and the balance Briar Hill (bituminous) coal. The object of the test was to determine the actual foot-pounds of duty per hundred pounds of fuel, and consequently no attention was paid to the temperature or weight of the feed water, neither to the condition of the hot well, nor the effective horse power of the engine.

The data for the calculations given were obtained as follows: Steam was raised to seventy pounds. the fires were hauled and the kindlings immediately put in, followed by the coal, which was carefully weighed by one of our number. When steam was raised to ninety pounds, the engines were started. At the close of the trial, the steam pressure was allowed to run down to seventy pounds, the fire hauled, and the engine stopped, the number of revolutions being shown by a reliable counter. The ashes and cinders remaining were then carefully sifted and the cinders deducted from the total amount of coal used. Hemlock wood was estimated at two-fifths the value of coal.

The engines pumped the usual city supply during the test at sixty pounds pressure, the surplus water flowing back into the suction channels through safety valves. The pressure was determined by two Ashcroft guages, from which readings were taken every half hour. These guages were fifteen and one-half feet from the surface of the water, in the suction channels under the engine room, and their height was added to that due to the pressure in the mains. In ascertaining the capacity of the pumps, their diameter and stroke were carefully measured by one of our number, and indicator diagrams taken to determine the perfection of their action. The diagrams were full and satisfactory in every instance, indicating a complete filling of the cylinders. In addition to this, the air cocks at the extremities of the pumps were examined at short intervals. No indication of the presence of air was observed at any time. This was undoubtedly owing to the good construction and condition of the pumps and their proximity to the suction surface—three or four feet.

Every facility for observation was cheerfully granted us by the engineers of the Holly Company who were present, and we are satisfied that all the conditions necessary to a test of this kind were faithfully complied with. It was the intention to continue the run twenty-four hours, in order to distribute possible errors and obtain better averages, but an order from the Water Board prevented its accomplishment. We feel assured, however, that the average given would have been kept up if not exceeded during the longer run, and it is obvious, since the order to shut down was unexpected, that no unusual effort was mad

by the attendants to obtain an extraordinary short run. Furthermore, by reason of the plan of hauling the fires at the beginning and at the end of the trial no errors in observing their condition (the usual practice) could arise.

The machinery worked well during the trial, and gave the attendants no trouble further than the usual lubrication. The extremes of water pressure were fifty-eight and one-half pounds, and sixty-one pounds; of steam pressure, ninety-three pounds and ninety-five pounds.

TABLE OF RESULTS.

Average pressure of steam during run, 92.3 pounds.
Average pressure of water in mains, 59.75 pounds.
Height due to that pressure, 137.425 feet.
Height from suction surface to guages, 15.5 feet.
Total height to which water was raised, 152.925 feet.
Diameter of pumps (4), 9.63-64 inches.
Length of stroke, 26.15-16 inches.
Gallons per revolution (4 pumps), 71.27.
Total revolutions during run, 11,506.
Gallons raised during run, 820,032.62.
Gallons raised in twenty-four hours, same rate, 2,989,483.
Revolutions per minute, average, 29.1.
Coal consumed during run, 1,650 pounds.
Actual duty per one hundred pounds of coal, 63,309,107 foot-pounds.
Duration of test, 6 hours and 35 minutes.

(Signed) J. E. BOOTH,
FRANK H. CLEMENT,
Committee.

CHIEF ENGINEER'S OFFICE,
ROCHESTER WATER WORKS, *August* 6th, 1874.

This is to certify that J. E. Booth and Frank H. Clement, were requested by me to be present and direct a duty test of the Steam Engine connected with the Rochester Water Works, the said Engine having been erected by the Holly Manufacturing Company; that the above named gentlemen did make such test and examination; that I know them to be excellent Mechanical Engineers, and I believe them entirely competent to conduct said test, and that full reliance may be placed upon the statements made by them in their foregoing report.

J. NELSON TUBBS,
Chief Engineer Rochester Water Works.

Holly Engine Duty Test at Evanston, Ill.

As preliminary to the acceptance of the set of Water Works Machinery constructed by the Holly Manufacturing Company, for the Village of Evanston, Ill., (a northern suburb of Chicago,) the Trustees of that Village appointed a committee of Engineers to make a duty

test of the engine, which is a smaller size than the Rochester works.

The following is the report of said Engineers:

To the President and Members of the Board of Trustees of the Village of Evanston:

Agreeably to your instructions, we have made a duty test of your engines at the Water Works, and have the honor to submit the following report:

The test began on Monday, March 1st, at 12:30 P. M., and continued until Tuesday, the 2d, at 6:08 A. M., or seventeen hours, thirty-eight minutes. A man was stationed in the engine room to read the pressure on the water gauge every five minutes; also to register the indications of the steam vacuum gauge, and counter every fifteen minutes. Another was placed in the boiler room to weigh the coal in lots of one hundred to three hundred pounds, and to keep a careful account of the same. A bench mark was established at the well, and a third man was detailed to take the distance to surface of water below bench every fifteen minutes. The height of the center of water gauge above bench was carefully ascertained by levelling. The water gauge had previously been tested and sealed in Chicago.

The engines work on the compound principle, one of the cylinders receiving live steam and exhausting into the other three. They had been running for several hours previous to the test, and were merely slowed at its commencement. The fire was drawn, and the grates and ash pit cleaned, and at 12:30 precisely, fresh fuel was thrown on the grate, and the counter started, the height of the water in the boiler being carefully noted, and the steam gauge indicating eighty-three pounds pressure. At the conclusion of the test the fire was allowed to run low, and the steam gauge again indicated eighty-three pounds, the height of the water in the boiler being the same as at starting. The fire was again immediately drawn, and the clinker, unconsumed coal, and contents of ash pit weighed. Only one boiler was used. The height of water in the well varied but little during the trial, the water pressure, steam pressure, and vacuum gauge remained nearly constant; every condition for a fair test was satisfied. The number of revolutions during the first part of the test was forty-two per minute, but during the latter part the engines were run at about thirty-six, steam being cut off at about three quarters stroke in all the cylinders. Rough calculations, made from time to time, indicated an increase of efficiency from the first, probably due to better stoking, and a more economical rate of speed. In order to keep up the requisite motion of the engine, water was allowed to escape by the safety valve in the water pipe. A few diagrams were taken from the upper end of one pump. They show remarkably square, clean cut corners, and a slight gradual descent on the upper side. The ends of the diagrams were straight; the lower side presented scarcely a variation, except at the beginning of the suction stroke, where there was a slight irregularity in the outline, which varied considerably in amount. The area of one diagram showing about the average variation was measured, and the loss indicated was less than eight-tenths of one per cent. A gauge attached to another pump showed practically the same pressure as on the mains, and a gradual but slight descent corresponding with the upper line of the diagrams. On the whole the pump diagrams were remarkably good.

The duty has been computed first on the gross weight of fuel fed into the furnace; second, on the net weight found by deducting the entire weight of cinders and ash drawn from the grates, and ash pit at the conclusion of the test; third, on the gross amount less one-third of the cinders and ash, two-third being allowed as combustible.

All the calculations on capacity are based on the size of pumps, as given by their measurements, no allowance being made for loss of any kind. The following summary gives the results of our labors, and includes such other items as may be of general interest:

DIMENSIONS.

Two boilers, (only one used,) plain cylindrical return flue, 5 feet diameter, and 16 feet long.

Fifty-four flues, $3\frac{5}{8}$ inches internal diameter.
Grate, 5 feet, 7 inches, by 6 feet, 6 inches.
Dome, 3 feet, by 5 feet, 4 inches.
Steam Pipe, 4 inch internal diameter.
Four Steam Cylinders, 24 inch diameter, and 24 inch stroke.
Piston rods, $2\frac{1}{2}$ inch diameter.
Two single acting air pumps, 14 inch diameter, and 14 inch stroke.
Boiler fed from hot well.
Four double acting pumps, 3—9 inch diameter, 1—$9\frac{1}{2}$ inch diameter, stroke 24 inches.
Piston rods, $2\frac{1}{2}$ inch diameter.
Inlet pipe, 16 inch diameter.
Discharge pipe, 16 inch diameter.

RESULTS.

Height from bench at well to center of gauge	15.73 feet.
Average distance from bench to surface of water	5.25 "
Total	20.98
Height reduced to pounds per square inch, water 56°	9.0885 pounds
Average pressure on gauge	61.2734 "
Allowance for friction between well and gauge, as at Lowell and Lynn	1.00 "
Total load on the pumps per square inch	71.3619 "
Available pump area per revolution	501.918 sq. in.
Foot pounds per revolution	71,635.6571 "
No. of revolutions in 17 hours and 38 minutes, or 1058 minutes	40,140
Total work in foot pounds	2,875,455,275.994
Seventy-five pounds of kindling, reckoned as coal	30 pounds
Briar Hill Bituminous coal	4700 "
Lehigh coal, Anthracite	500 "
Total	5230
Duty per 100 pounds of coal, (no deduction)	54,980,024 ft. lbs.

Amount hauled from furnace	248.5 pounds
Amount hauled from ash pit	66.0 "
	314.5 "
Net fuel	4915.5 pounds
Duty per 100 pounds of coal, cinders and ash deducted	58,497,717 ft. lbs.
Duty per 100 pounds of coal, ½ of cinders and ash deducted	56,684,313 ft. lbs.
Capacity of pumps per 24 hours, at 27 revolutions per minute	2,027,487 gallons
Average No. of revolutions per minute during test	37.93
Capacity of pumps per 24 hours, at this speed	2,848,243 gallons
Capacity per hour	118,676.8 "
Average steam pressure	65.9 pounds
Average vacuum	25.2 inches.
Barometer	29.764 "
Temperature of hot well	90° to 92°

J. R. FITCH.
LYMAN E. COOLEY.
H. S. CARHART.

Evanston, Ill., May 14, 1875.

Comparative Table of Reported Duty of Water Works Pumping Engines.

Location of Works.	Style of Engine.	Date.	Duty in pounds of water raised one foot high, with 100 pounds coal.	REMARKS.
Fairmount, Philadelphia	Worthington Duplex		[illegible]	
" "	" "	[illegible]	[illegible]	Actual duty.
" "	" "	[illegible]	[illegible]	Same test, allowing [illegible] of [illegible] lbs. water to one lb. coal.
Brooklyn, N. Y.	Double Acting Beam	[illegible]	[illegible]	Test made for acceptance at Ridgewood.
" "	" " "	[illegible]	[illegible]	Engine No. [illegible]. Av'ge for the
" "	" " "	[illegible]	[illegible]	Engine No. [illegible]. Year.
" "	Beam		[illegible]	
" "	Beam and Rotative		[illegible]	
Buffalo, N. Y.	Beam, Shipped from Wales	[illegible]	[illegible]	
" "	" " " "	[illegible]	[illegible]	
" "	Holly, condensing	[illegible]	[illegible]	Average for the year, using Pump of six cylinders, [illegible] water supply.
Cambridge, Mass.	Worthington Duplex		[illegible]	
" "	" "	[illegible]	[illegible]	
Charlestown, Mass.	" "	[illegible]	[illegible]	
" "	" "	[illegible]	[illegible]	
" "	" "	[illegible]	[illegible]	Average of 4 years.
Chicago, Ill.	Rotative	[illegible]	[illegible]	
" "	Designed by D. C. Cregier	[illegible]	[illegible]	North engine.
" "	" " " "	[illegible]	[illegible]	South engine, [illegible] gallons in 24 hours.
Cleveland, Ohio	Cornish		[illegible]	
" "	"	[illegible]	[illegible]	First engine.
" "	"	[illegible]	[illegible]	Second engine.
Delaware, Philadelphia	Rotative		[illegible]	
Detroit, Mich.			[illegible]	
Evanston, Ill.	Holly, compound	[illegible]	[illegible]	Using Hill Coal.
" "	" "	[illegible]	[illegible]	" " " Screenings.
" "	" "	[illegible]	[illegible]	[illegible]
" "	" "	[illegible]	[illegible]	[illegible] coal.
			[illegible]	Test made for acceptance. Combustion changed.
" "	" "	[illegible]		
			[illegible]	All coal charged.
Fall River, Mass.	Cornish, Boston Mach. Co.	[illegible]	[illegible]	Average.
" "	Same Engine	[illegible]	[illegible]	Highest duty given.
Germantown, Phil.	Rotative		[illegible]	
Harrisburg, Pa.	Worthington Duplex & Corn.	[illegible]	[illegible]	
Jersey City, N. J.	Cornish	[illegible]	[illegible]	Engine No. 1.
" " "	"	[illegible]	[illegible]	
" " "	Worthington Duplex	[illegible]	[illegible]	
Hartford, Conn.	Cornish	[illegible]	[illegible]	Mean of three experiments.
Louisville, Ky.	Cornish	[illegible]	[illegible]	Average for the Year.
" "	"	[illegible]	[illegible]	
Lowell, Mass.	Rotative		[illegible]	
Montreal, Canada	Rotative		[illegible]	
Newark, N. J.	Worthington Duplex		[illegible]	

Location of Works.	Style of Engine.	Date.	Duty in pounds of water raised one foot high, with 100 pounds coal.	REMARKS.
Philadelphia, 24th Ward	Rotative	....	38,880,246	
Providence, R. I	Corliss	1874	25,865,740	Direct water supply; test for Acceptance.
Providence, R. I	Corliss	1874	8,487,370	Running at ordinary speed.
" "	Worthington Duplex	1874	53,528,210	Test at 2-5 maximum capacity.
Rahway, N. J.	""	1873	16,922,940	Average for a week, direct water supply.
Rochester, N. Y	Holly, compound	1874	59,553,000	Anthracite coal, coal all charged.
" "	" "	1874	66,787.000	Combustible only charged.
" "	" "	1874	67,368,000	Combustible only charged.
" "	" "	1874	69,236,000	Combustible only charged.
" "	" "	1874	75,087,000	Combustible only charged.
" "	" "	1874	62,515,000	Coal all charged.
" "	" "	1874	63,309,107	Certified test, coal all charged.
" "	" condensing	1874	35,542,000	Not compounding, engine running as for throwing fire streams.
Roxboro, Philadelphia	Cornish	....	40,549,080	
Salem, Mass.	Worthington Duplex	....	42,369,146	
Schuylkill, Philadelphia	Two cornish & low pressure	1869	35,487,264	
Sacramento, Cal	Holly, compound	1874	57,000,000	Making fair allowance for inferior lignite coal.

The above tabular statements, compiled from official reports, show that Holly's New Compound Direct-Supply Pumping Engine ranks among the very best. Taking the highest duty test of Holly Engines at Rochester, (test No. 12, see page 37), 75.087.000, and the expert's test at same place, (see page 40–1), 63.309.107 ; also, the expert's test at Evanston, (see page 43–4), make an average of 64.829.806 pounds of water raised one foot high, with one hundred pounds of coal. Taking the two best tests of other engines in the above table, those of the Worthington Duplex Compound, one at Charlestown, 65.538.675, the other at Cambridge, 67,774.630, and the expert's test of another engine of the same kind at Belmont, where the actual duty as reported, was 54.416.694, gives an average duty of 62.576.666, foot pounds for 100 pounds coal; or 2.253.140 excess in favor of the Holly engine.

It will be seen further by the above table, that the Holly Engines at Evanston gives a duty of 24.700.000 *foot pounds*, for 100 *pounds coal*

screenings, and this WHEN RUNNING AT ONLY ONE THIRTEENTH ITS MAXIMUM CAPACITY, and pumping directly into the water mains. In comparison with this, it is worthy of notice, that the Worthington Duplex Compound Engine at Rahway, N. J., the only engine of this kind pumping directly into the mains, gives a duty of but 16,911,940 foot pounds, with 100 pounds Anthracite, the kind of coal used at those works. And that the Corliss Engine at Providence, also pumping directly into the mains on the Holly plan, when running at the ordinary rate of speed for domestic supply, shows a duty of only 8,487,379 foot pounds, with 100 pounds Antracite coal. These statements of facts in the matter of duty of engines when pumping with variable motion and at partial capacity directly into the mains, places the Holly Compound Engines unquestionably far in advance of all competitors. It will be seen therefore, that whether pumping at full capacity or running at slower rate of speed for the regular daily supply, and in adaption to the varying demands for water for fire protection and domestic uses, the Holly Engines as now constructed, are superior to all others.

The legal questions involved by infringements of Holly's Patents at Rahway and Providence, are to be determined by the courts, and a suit in the former case is now pending.

The popularity and great demand for Water Works on the Holly Plan has sensibly affected the interests of certain Engineers and Manufacturers accustomed to construct gravitation works. They have sought in vain by ridicule and misrepresentation to disparage the Holly System, and yet communities in spite of their efforts, would adopt Holly instead of the kind of works they recommended, and to which they were attached by long and profitable experience. Next the opposition devoted its energies to alleged mistakes in the details of construction in certain localities. Holly was made responsible for everything. Jackson, (Mich.) did not bury her pipes deep enough to escape frost, and the cry went up the Holly Plan is a failure. A wall of the Water Works Building at Evansville, (Ind.) falls down and the expense of its construction is adduced in proof that the repairs of Holly Machinery is unusually great. The city of Columbus, (Ohio) calls in an engineer to plan and estimate for increasing the volume of water into wells from which the Holly Pumps distribute it to the city, and madam rumor confidently recounts that the Holly Works in Columbus are a failure. Sundry places enlarge and change the combinations of

Holly Machinery to meet increased and unexpected demands for water, and the fact is trumpeted in proof that Holly Machinery is of inferior quality.

The preceding statements, as to economy of the Pumping Engines now manufactured by the Holly Manufacturing Company, fully meet and refute these unfounded and infurious allegations, and place Holly Machinery in style, finish, adaptation and economy of service, as equal to any and superior to most of the Pumping Engines now in use throughout the country.

In this connection another word of explanation is proper. When Mr. Holly began his direct pumping operations, he was constructing only his Patent Eliptical Rotary Pumps, and they were of course exclusively used in his earlier Water Works. For fire service this pump is unequalled. It can be run safely at a high rate of speed and meet extraordinary emergencies of fire. Not so a Piston Pump. It is best adapted for comparatively slow motion. Mr. Holly was taught by experience that a combination of the kinds of pumps was productive of the best results—a piston pump for daily supply and the rotary pump held in reserve for fire service. Hence several of the earliest Holly Works on the recommendation of Mr. Holly, had additions of piston pumps for daily supply, so as to leave the rotary for the fire streams service, for which it is so peculiarly adapted. The piston pump thus devised and put in operation in several localities, was a six-cylinder pump, taking stroke in regular succession. It had many advantages and never failed in any instance to perform all that was guaranteed for it. By reference to the table of duties, page 45, it will be found that a pump of this class gave an average duty of 37,500,000 foot pounds for the year, at Buffalo, which is far in excess of that of the Worthington Engine at Rahway, or the Corliss Engine at Providence, both of which are operating under similar conditions of service. But Mr. Holly sought for still greater improvements, and in due time brought out his four-cylinder, direct acting compound pumping engine, as now manufactured by the Holly Manufacturing Company, with which he is connected. In this new engine the objections to the other styles do not exist, and he has succeeded in securing as high duty with it when pumping directly into the mains, as any of the long established, recently improved engines can give when pumping steadily, without intermission in pressure or speed, into reservoirs or stand pipes, thus exploding the theory of such as claim that economy in the use of fuel cannot be obtained by the Holly direct supply plan. It should be borne in mind therefore that the many harsh and unjust criticisms upon Holly Machinery applies either to the rotary pump as used for domestic supply, or the six-cylinder pump above referred to, and does not touch the question as to the merits of the compound four-cylinder pumping engine now offered as the daily supply pump, and whose splendid duty tests, as previously recorded, place it with the foremost in the list of water works engines. The conclusion of the whole matter is that Holly's Plan and Holly's Machinery are superior to all others for supplying communities with water and protecting property from destruction or damage by fire.

Holly Manufacturing Company,

LOCKPORT, N. Y.,

MANUFACTURERS OF THE

HOLLY WATER WORKS

—AND—

FIRE HYDRANTS

FOR CITIES AND VILLAGES.

—ALSO—

LIFT AND FORCE PUMPS,

ELLIPTICAL ROTARY PUMPS, TURBINE WATER WHEELS,

STEAM ENGINES,

PORTABLE AND STATIONARY, BOTH ROTARY AND PISTON,

AIR AND GAS PUMPS,

WRECKING AND MARINE PUMPS, ALSO LIFT AND FORCE PUMPS FOR HAND,

IN ALL VARIETIES

DESCRIPTION OF THE TWO FOLLOWING CUTS.

The cuts on the following page represent the exterior and sectional views of Holly's Patent Fire Hydrant The outer case is set in the ground at the required depth, and to which the earth will freeze, so as to adhere in severe weather. It has also inner stem through which water is forced for fire or other purposes, Between the case and stem is a space for air. The valve is at the bottom of case, and so far underground as to be entirely out of reach of frost, and is operated upon by valve rod, the screw and nut of which are immediately above the valve, and so secured as to prevent any vibration under very heavy pressure. The valve seat is of leather, and valves opens against and close with current. In order to get at the valve take out the four bolts at the surface of the ground, the inner stem with valve, and the whole working part of the Hydrant can then be taken out, examined or repacked and replaced without difficulty. making the joint at the bottom of stem tight by tightening the four bolts at surface of ground. It is so arranged that when the valve is closed all the water in the case above valve will run out, leaving the Hydrant empty at all times, except in case of fire, or when water is rapidly passing through it, and as the valve is so constructed that it will not leak one drop, it is impossible for frost ever to affect this Hydrant The act of opening the valve closes the drip and prevents any water escaping while the Hydrant is being used. A guard at the top prevents any unauthorized persons using them. as they cannot be opened except with lock-wrench, constructed especially for this purpose. There has no case been reported where one of these Hydrants has frozen when properly set, and they have been placed under pressure equal to five hundred feet head, without leaking one drop. They are of extra weight and strength, and adapted especially for use in connection with Holly Water Works.

HOLLY'S PATENT FIRE HYDRANT.

Sectional View.

Exterior View.